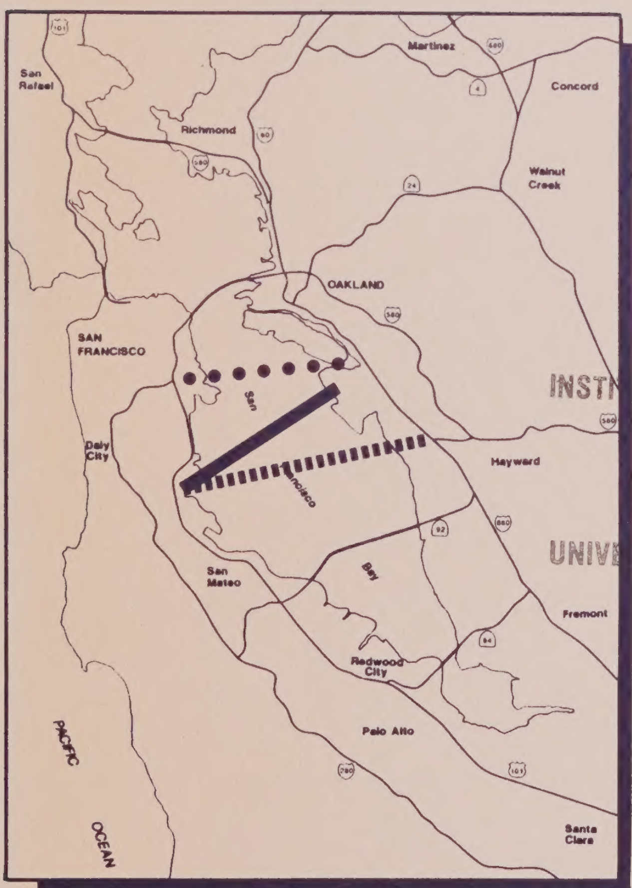
SAN FRANCISCO BAY CROSSING STUDY

FINAL REPORT

PREPARED FOR

METROPOLITAN TRANSPORTATION COMMISSION



MARCH 1991

PREPARED BY

Korve Engineering, Inc.

and
Associated Subconsultants

San Francisco Bay Crossing Study

Prepared by
Korve Engineering, Inc.
and Associated Subconsultants

Prepared for

Metropolitan Transportation Commisison
101 Eighth Street
Oakland, California 94607-4700
(415) 464-7700

March 1991

Acknowledgements

Metropolitan Transportation Commission
Henry Dittmar, Project Manager
David Tannehill
Milos Vrcelj

Korve Engineering, Inc. -- Engineering Consultants
Hans Korve, P.E.
Brent Ogden, P.E.
Robert Grandy, P.E.
Norman Spersrud
Susan Foster
Holly Sellers
Kevin Keck

Subconsultants:

Linda Peirce Associates, Inc. -- Environmental and Socio-Economic Assessment
Linda Peirce
Douglas Donaldson

Dowling Associates -- Traffic Modelling
Richard Dowling
Steven Lowens

Sverdrup Corporation - Engineering Feasibility and Cost Estimates
Thomas Jee, P.E.

Morris Guralnick Associates, Inc. - Ferry Consultants
Leonard Stanton

Walter Kudlick Associates - Transit Consultant
Walter Kudlick

The Metropolitan Transportation Commission (MTC) is a metropolitan planning organization established pursuant to California Government Code Section 66500 et. seq. (1970) to provide comprehensive transportation planning for the nine Bay Area counties of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma.

Policy direction is provided by 17 Commissioners. Fourteen members are appointed directly by locally elected officials, two members represent other regional agencies (the Association of Bay Area Governments and the Bay Conservation and Development Commission), and one non-voting member represents the California Department of Transportation.

Technical Advisory Committee

Mike Anderson, East Bay Regional Park District
Jim DeHart, SamTrans
Dennis Fay, Alameda County Public Works
John Glover, Port of Oakland
George Gray, Caltrans
Steve Heminger, Office of State Senator Quentin Kopp
Merle Johnson, Caltrans - Transportation Studies
Geoffrey Kline, San Mateo County Public Works
Rebecca Kohlstrand, San Francisco Planning
Jim Lightbody, Santa Clara County
Robert McCleary, Contra Costa County Transportation Agency
Alan Pendleton, Bay Conservation & Development Commission
Ken Stanley, AC Transit
Alan Lee, BART
Marianne A. Payne, BART
Ann Whittington, Port of Oakland
Jason Yuen, San Francisco International Airport

Advisory Committee

Member:	**Representing:**
John Asmus	SamTrans
Jack Drago	San Mateo Council of Mayors
Jim Gonzalez	Speaker of the California State Assembly
Tom Huening	San Mateo County Board of Supervisors
Tonton Heffelfinger	Environmental Community
Doris Kahn	Office of the Mayor of San Francisco
George L. Livingston (alternate)	Contra Costa County Council of Mayors
Mehdi Morshed	California Senate Committee on Rules
Larry Orman	Environmental Community
Alan Pendelton	Bay Conservation and Development Committee
Barbara Peterson	Environmental Community
Norman Rolfe	San Francisco Board of Supervisors
Terry Roberts	Office of the Mayor of Oakland
Charles Santana	Alameda County Board of Supervisors
Robert I. Schroder	Contra Costa County Board of Supervisors
Del Pierce	Secretary Business, Transportation and Housing
Dave Karp	Alameda Council of Mayors

MTC Policy Committee

Commissioner Steve Weir
Commissioner James Spering
Commissioner Angelo Siracusa
Commissioner Tom Nolan
Commissioner Dianne McKenna
Commissioner Dave Karp,
Commissioner Harry G. Britt

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

Figure **Page**

LIST OF FIGURES

LIST OF FIGURES

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES

1. INTRODUCTION & SUMMARY

SECTION 1
INTRODUCTION AND SUMMARY OF FINDINGS

1.1 INTRODUCTION

Inception of Study

This report presents the results of a comprehensive initial evaluation of the travel characteristics, environmental impacts, costs, and financial feasibility of transportation improvements which would increase the capacity and mobility options for transbay travel between San Francisco and the Peninsula and the East Bay, and points along the Carquinez Strait including Vallejo, Benicia, and Martinez. This evaluation is an examination of only one corridor, and did not evaluate transportation improvements or financial impacts on a Bay Area-wide scale. This initial evaluation does not attempt to identify or recommend a preferred transportation alternative. In addition, this is a preliminary feasibility study and not a scoping study.

The evaluation was performed pursuant to California Senate Concurrent Resolution No. 20 (SCR-20), which recognizes:

- "San Francisco-Oakland Bay Bridge and the San Francisco Bay Area Rapid Transit District trains, which cross under San Francisco Bay in the vicinity of the Bay Bridge, have been operating at full or nearly full capacity for some time;

- Travel demand between the east and west sides of the Bay is expected to continue to grow;

- A large proportion of vehicular traffic between the east and west sides of San Francisco Bay is not destined for Oakland or San Francisco; and

- Bay Area community leaders are requesting that a bridge or tunnel be constructed to relieve traffic on the Bay Bridge."

In accordance with SCR-20, the following topics are addressed:

- Current and predicted patterns of land development and travel demand patterns;

- Current and predicted transportation facilities, including an inventory of potential capital and operating improvements which would facilitate transbay travel over, under, or on San Francisco Bay;

- Identification of the most promising locations for additional transbay crossings, approaches, and terminals;

- Preliminary consideration of environmental issues related to new transbay crossings; and

- Comparative analysis of costs and benefits of expanding existing bay crossings and of constructing additional crossings.

Study Process

The identification and analysis of bay crossing alternatives was conducted using a "two-cycle" process. An initial set of 11 build alternatives were identified and evaluated using preliminary travel demand, feasibility, and cost information. As a result, five build alternatives were selected for further study and full evaluation.

The study took direction from three groups:

- Technical Advisory Committee (TAC) -- The TAC consisted of staff members from various agencies involved in Bay area transportation planning, including MTC, BART, CalTrans, AC Transit, Port of Oakland, San Francisco International Airport, East Bay Regional Park District, San Francisco Public Utilities Commission, and others. The TAC, along with assigned MTC staff, provided primary technical oversight of the study.

- Advisory Committee -- The Advisory Committee, established by SCR-20, included three members appointed by MTC from lists of nominees submitted by environmental organizations, one member appointed by the Senate Committee on Rules, one by the Speaker of the Assembly, one by the Mayor of San Francisco, one by the Mayor of Oakland, one by the San Francisco Board of Supervisors, one each by the Boards of Supervisors of Alameda, Contra Costa, and San Mateo Counties, one each by the Council of Mayors of Alameda, Contra Costa and San Mateo Counties, one by the San Francisco Bay Conservation and Development Commission, one by the San Mateo County Transit District, and one by the Secretary of Business, Transportation and Housing. The Advisory Committee was established to review and comment upon the work of MTC and its consultant.

- Policy Committee -- SCR-20 further required MTC to meet and confer frequently with the Advisory Committee. For this purpose, MTC established the Policy Committee as a liaison panel between the full commission and the Advisory Committee. The MTC Policy Committee met jointly with the Advisory Committee to review and comment upon the progress of the study. At the conclusion of the study, the Policy Committee will provide the full commission with its conclusions based upon the study.

Progress on the study was presented to the TAC, Advisory Committee and Policy Committee through a series of reports on various topics which are represented as sections in the final report.

Study Alternatives

Six alternatives were studied; five "build" options and a base case:

- Base Case (RTP Highway/Transit Blend)

- Alternative 1 -- Expanded High-Speed Ferry System

- Alternative 4 -- Highway Bridge (I-380 to I-238) with BART Connecting San Francisco International Airport with New Dublin-Pleasanton Line

- Alternative 6 -- New BART Tube Connecting San Francisco International Airport with Oakland International Airport and New Dublin-Pleasanton Line

- Alternative 8 -- New BART Tube Parallel to Existing Transbay Tube with New Subway in San Francisco and New 4th Track through Oakland

- Alternative 11 -- Heavy Rail Tunnel Connecting Peninsula Lines with Lines in Vicinity of Port of Oakland

1.2 SUMMARY OF FINDINGS

The following key findings resulted from the travel analysis of the alternatives:

- Transbay travel demand (highway plus transit person-trips) will increase by approximately 25 percent by the Year 2010. This demand increase would occur with or without construction of a new bay crossing; construction of a new bay crossing would not significantly further increase transbay travel demand. (See Figure 4-1.)

- The base case RTP Blend set of improvements, which includes widening of the San Mateo Bridge to six lanes and more frequent BART transbay service, will provide enough capacity to accommodate the 715,000 daily person-trips crossing the Bay in the study area in the Year 2010.

- The Bay Bridge is at maximum capacity for 1.5 hours today, with heavy congestion over a longer period. With Year 2010 travel demand and no new bridge, the Bay Bridge would be at maximum capacity for 3.5 hours and heavy congestion would extend over an even longer period. (See Figure 4-4.)

- Peak hour BART load factors on transbay lines exceed policy levels today. Capacity increases due to anticipated reduction in BART headways in the transbay tube would increase capacity by about 50 percent by the Year 2010,

however, at that time, BART would again be approximately at capacity due to projected travel demand increases.

- Of five bay crossing build alternatives studied, a mid-bay bridge in the I-380/I-238 corridor with BART would carry the greatest number of daily trips. Year 2010 travel on such a facility would be similar to the current level of travel accommodated on the Dumbarton Bridge. These trips could be accommodated on the existing bridges and BART, though there would be greater congestion, longer travel times, and a 3.5 hour peak period on the Bay Bridge.

- Although originally defined as an eight-lane facility with BART, travel model results indicate the facility could be constructed with four travel lanes plus a shoulder similar to the Dumbarton Bridge.

- A new bridge crossing with BART in the median would reduce daily volumes on the Bay Bridge by 15,000 vehicles and would reduce volumes on the San Mateo Bridge by 6,000 vehicles. Peak hour volumes on the Bay Bridge would not be significantly reduced; however, the duration of the peak period on the Bay Bridge would be shortened by one hour or more. (Without additional bay crossing capacity, the length of peak period on the Bay Bridge is forecast to more than double compared to today's condition.) By providing a "missing link" in the Bay Area highway network, regional highway vehicle miles traveled would be reduced by about 2-million daily from the RTP blend scenario total of 111 million daily vehicle miles travelled.

- In addition to relieving the Bay Bridge, a new bay crossing would serve an emerging mid-bay travel market, which will increase over the next 20 years. For example, the new bridge would cut peak-hour travel times between the Oakland Airport and the San Francisco Airport by 20 minutes. (See Figure 4-6.) The amount of travel between the two airports was not assessed in this study.

- Of the various transit lines studied, a second BART tunnel across the Bay (Alternative 6) at the same approximate location as a new highway bridge, linking the San Francisco Airport with Oakland Airport, would attract the greatest number of trips. (BART operating on a new highway bridge would attract 80 percent of the trips as a "BART-only" tube.)

- Ferry system enhancements (Alternative 1) consisting of additional routes with faster vessels operating on frequent headways could result in ferry ridership many times today's levels. Of the routes studied, highest ridership was obtained in the congested I-80 highway corridor north of the Bay Bridge. This service would relieve the Bay Bridge.

- A sensitivity analysis conducted for this study showed that a four-dollar toll increase applied to all bridge crossings in the study area would reduce transbay vehicular demand by as much as 13 percent. However, transit demand would increase by 10 percent, therefore pushing BART load factors further above capacity.

- An "infill" alternative land use scenario was run by MTC for the RTP. The result of this test indicated that transit ridership would increase by about 12 percent regionwide, highway volumes would also increase about 4 percent regionwide, and transbay travel would increase by an additional 6 percent. This land use would therefore further strain the capacity of the BART transbay tube and existing highway crossings.

- While the Year 2010 demand can be met by pushing the highway and BART systems to capacity for trips to San Francisco, continued growth in employment in San Francisco and northern San Mateo Counties beyond that year would exceed the bay crossing capacity provided in the RTP Blend if current trends continue.

- Given that capacity in the BART tube and Bay Bridge would be a critical issue in the Year 2010, a land use assessment and transportation forecast capability must

be developed to plan adequately for the Year 2010 - 2030 era when substantial capacity increases for transbay travel may be necessary.

The following findings resulted from the environmental and socio-economic assessment:

- The Base Case (RTP "Blend") assumes certain improvements to the transportation network as proposed in the Regional Transportation Plan. (For example, this includes the widening of the trestle portion of the San Mateo Bridge from four to six lanes). The impacts associated with these Base Case improvements were not evaluated as a part of this study. Such impacts will be evaluated in a separate EIR being prepared for the Regional Transportation Plan by MTC.

- The enhanced ferry system alternative resulted in the lowest levels of environmental and socio-economic impacts overall relative to the total alternatives examined.

- Construction of a new bridge would have significant land use impacts. These impacts are most severe in the East Bay, where the proposed freeway structure would cut through established neighborhoods, displacing homes (110-120 units under Alternative 4) and creating a physical barrier between neighborhoods, with the resultant noise, vibration, visual, dust and particulates, and construction impacts. The proposed I-880/SR-238 Interchange would displace businesses in San Leandro's retail center.

- Dredging and water quality impacts would be significant with all of the tunnel options examined. In particular, the Airport-to-Airport BART tube would result in dredging of as much as 11.8 million cubic yards, equivalent to the annual average for all dredging activity in the Bay in 1986 and 1987. Disposition of dredge spoils is an unresolved policy issue that could significantly affect the viability of tunnel options. (A dual transbay BART tube or rail tunnel would have lower impacts due to the shorter length of the alignments compared to an airport-airport crossing.)

- Ecology impacts would be significant with implementation of Alternative 4 (Bridge) and Alternative 6 (Airport-to-Airport BART) due to the presence of known wetlands

and sensitive habitat resources. In addition, two endangered species, the San Francisco Garter Snake and Salt Marsh Harvest Mouse, are known to exist in areas possibly affected by Alternative 4.

- All of the Alternatives would, as a result of their location, tend to reinforce the existing urban patterns of development and location of metropolitan centers in the East and West Bay. By encouraging infill development, rather than growth in new areas, all of the Alternatives can be considered growth-directing rather than growth-inducing.

The following key findings resulted from the cost evaluation:

- As originally formulated, the enhanced ferry services alternative (with some 17 routes) would not be a "low" cost option. However, a scaled-down alternative consisting of the five top lines, would enhance travel options at low cost.

- A downsized new bridge providing four lanes of highway travel and with adequate foundation and vertical support for the addition of BART at a later date would be the most cost-effective solution of the alternatives studied.

- BART could be added to a four-lane bridge with a lower cost ($700-million as opposed to $2.4 billion - $3.7 billion for BART Alternatives 8 and 6, respectively) and insignificant dredging impacts compared to a new BART tube.

- The cost per person trip of a new bridge with BART would be significantly lower than all other alternatives, largely due to higher travel levels which would occur with inclusion of the highway mode.

The following key findings resulted from the financial evaluation:

- A four dollar increase in tolls (on the southern bridge group) in the Year 2000 would generate approximately 1.5 billion dollars in bonding capacity through the Year 2030. Other funding sources may include federal Interstate funds or Urban Mass Transportation Authority (UMTA) funds.

- A four dollar toll increase in the Year 2000, when discounted to 1990 levels, is comparable to charging $3.50 for a bay crossing trip, which is similar to toll levels for trans-Hudson crossings in the New York metropolitan area. Recent public opinion polls have indicated a willingness by Bay Area citizens to accept higher tolls.

- A four dollar toll increase would be sufficient to fund the enhancement of the ferry system capital plus operating costs, construction of a new four-lane highway bridge, or a heavy rail tunnel. This level of increase would also cover most of the cost of a new bridge with BART or a lesser portion of a new BART tunnel.

- The cash flow generated exclusively on the new bridge crossing from a $10 toll increase is not sufficient to support private financing of the bridge's construction.

- Financing a bay crossing alternative may preclude or delay toll financing of other important transit or highway improvements in the region for which it may be desirable to use bridge toll monies. Some of the other projects being considered include:

Project	Cost (millions of 1990 dollars)
BART to San Jose (East Bay)	$1,800
BART from San Jose to Palo Alto	922
Dumbarton Rail Corridor	36
Oakland Airport Connector	132
BART SFO to Santa Clara Co	853
Muni Bayshore Corridor	294
Muni Geary Corridor	600
BART to Livermore	481
Unfunded Tier I Rail Extensions	145
Total	$5,263

To provide a comparison with the study alternatives, the projects above show some of the other significant improvements being considered in the study corridor. These costs generally represent the high end of the estimates. In addition to the projects above, significant funding will also be needed for seismic retrofitting of existing bridges in the Bay Area.

The evaluation identified the following findings relative to benefit to cost:

- A highway bridge with BART at a later date in the I-380/I-238 alignment would have the highest cost-effectiveness, and would provide a high benefit/low cost solution relative to other bay crossing alternatives.

- An enhanced ferry system would be moderately cost effective, providing a low benefit/low cost means of providing additional bay crossing capacity. An enhanced ferry system could be expanded incrementally and could provide a near-term solution for locations which do not have good competing transit services and where substantial highway congestion exists.

- A heavy inter-city rail tunnel between San Francisco and Oakland would also be moderately cost effective, providing a relatively low-cost means of providing additional bay crossing capacity.

1.3 RECOMMENDATIONS FOR FURTHER STUDY

1. Ferry system expansion and enhancements offer a relatively inexpensive means of adding bay crossing capacity and providing new transit options. Effort should be undertaken to identifying the most cost-effective means of expanding ferry services between selected points. (A study is currently underway to provide a more detailed definition of an improved Bay Area ferry system including near-term improvements to the promising Vallejo-San Francisco route.)

2. The RTP Blend transbay-related improvements should be financed and constructed. These include widening the San Mateo Bridge to six lanes, approach improvements to the Dumbarton Bridge and San Mateo Bridge, certain ferry services improvements, transit access improvements, and increased BART transbay frequencies. These improvements would accommodate the projected 23 percent increase in transbay travel through the Year 2010.

3. Further travel forecasting effort is necessary to develop refined projections of highway travel, to explore the systemwide impact of a new bridge, and to more carefully consider potential transbay transit markets in the Year 2010 and beyond.

4. While this study found that planned BART transbay capacity increases and further extension of the peak period on the Bay Bridge may absorb a significant portion of additional travel demand until the Year 2010, at that point in time a critical capacity condition will occur. It is therefore very important that longer-term land use and travel forecasts be developed in order to plan for new bay crossing facilities needed over the longer term.

2. ISSUES & PRELIMINARY ALTERNATIVES

SECTION 2
ISSUES IDENTIFICATION FOR PRELIMINARY ALTERNATIVES

The purpose of this chapter is to identify and discuss issues relating to the ten preliminary alternatives for upgrading transbay mobility.

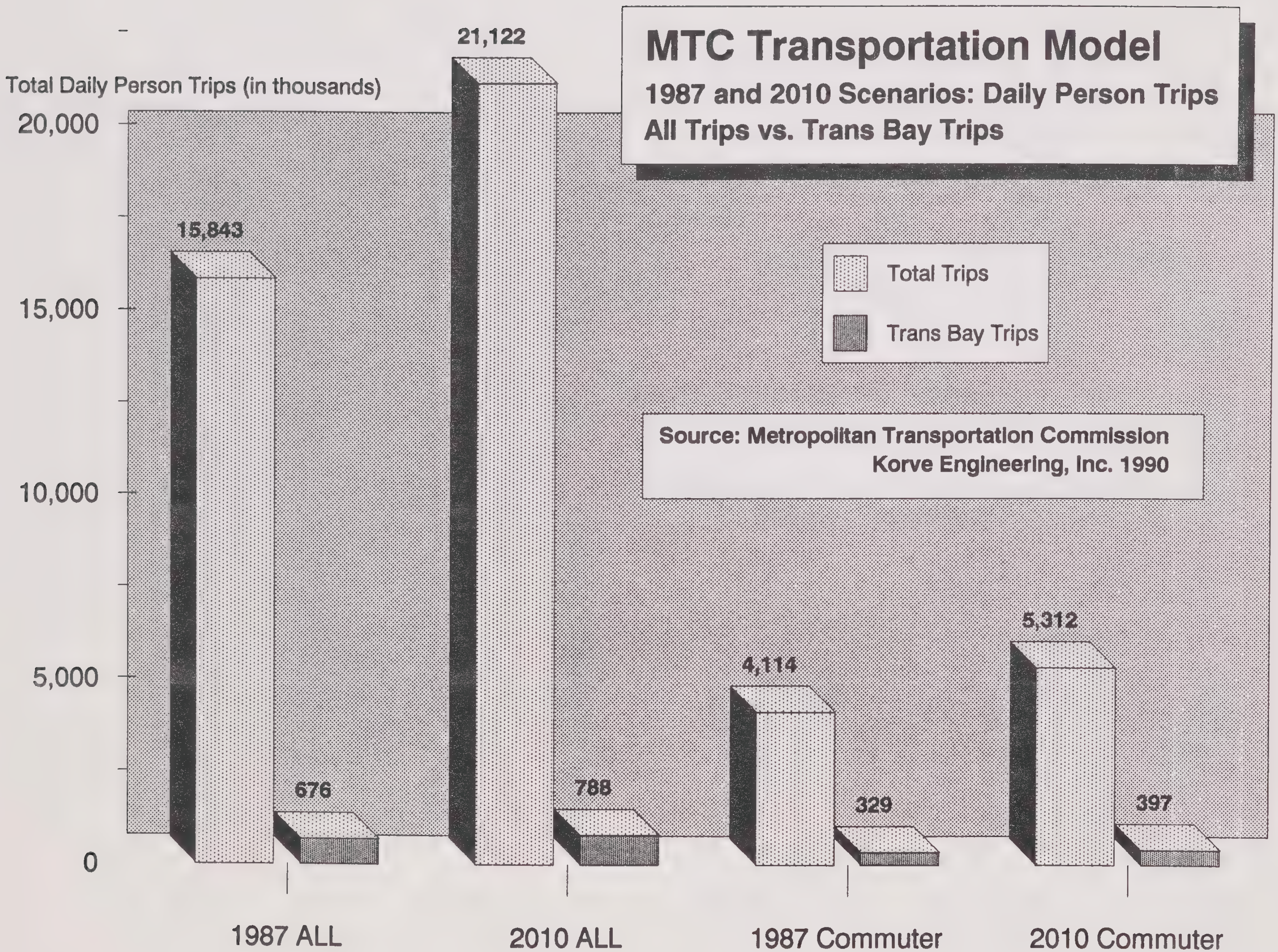
To provide a basis for establishing the demand for transbay travel, this report presents information on existing and future travel patterns across San Francisco Bay (the Bay). The travel data, which is derived from MTC's regional model, indicates the demand (in person trips) from five major areas in the West Bay to and from five major areas in the East Bay. This demand is shown graphically as "desire lines" that indicate the destination of travellers crossing the Bay irrespective of the location of existing facilities. As such, it provides an initial perspective on how the various alternatives might serve future transbay travel needs.

The preliminary discussion of key issues is designed to assist in the process of refining or eliminating infeasible or undesirable alternatives. The three primary topics that are described include environmental concerns, engineering constructability, and order-of-magnitude construction costs.

2.1 TRANSBAY TRAVEL PATTERNS

This section presents our preliminary analysis of the existing and future San Francisco transbay travel market. The following data is drawn from the most recent trip tables for the Metropolitan Transportation Commission's (MTC)'s nine-county Bay Area transportation model. The source of the information is the 1980 Journey to Work trip tables.

Figure 2-1 shows a graphic comparison of all transbay travel (e.g., both transit and vehicular), in person trips, to all travel. (Two sets of bars are shown; one is for all trip purposes while the other is for commute trips only.) Clearly, transbay trips are a small percentage of daily travel in the whole Bay Area. On the other hand, collectively these trips do form a significant proportion of Bay Area travel, especially from the perspective of those travel zones which either generate or attract these trips.



MTC Transportation Model
1987 and 2010 Scenarios: Daily Person Trips
All Trips vs. Trans Bay Trips
Total Daily Person Trips (in thousands)
20,000
15,000
10,000
5,000
0
21,122
15,843
676
788
4,114
329
5,312
397
Total Trips
Trans Bay Trips
Source: Metropolitan Transportation Commission
Korve Engineering, Inc. 1990
1987 ALL
2010 ALL
1987 Commuter
2010 Commuter

Figure 2-1

The following analysis of transbay travel is not constrained by demand management measures. This analysis will be prepared later in the study after MTC completes the process of developing mitigation measures for the State Clean Air Act.

Bay Crossing Travel Demand

For the purposes of this preliminary assessment, we have defined a set of ten "bay crossing" zones (five on each side of the Bay). It is expected that cross-bay travel between these zones will compromise most of the potential travel demand for bay crossing facilities, excepting special traffic such as airport-to-airport shuttle services, or certain goods movements which may not be included in the MTC model.

In order to identify travel demand for crossing facilities, travel demand between sub-areas (e.g., zones) on either side of the Bay is tabulated. Ten zones are defined, five on each side of the Bay. Numbered counterclockwise, 0-9, beginning with Marin, these zones are comprised of varying numbers of superdistricts. Each of the five opposing zones may be thought of as a "transbay trip-shed". That is, each represents a distinct corridor from which a crossing approach, or exit, would likely be made. Table 2-1 identifies the zones, the areas they cover, and the corresponding MTC superdistricts.

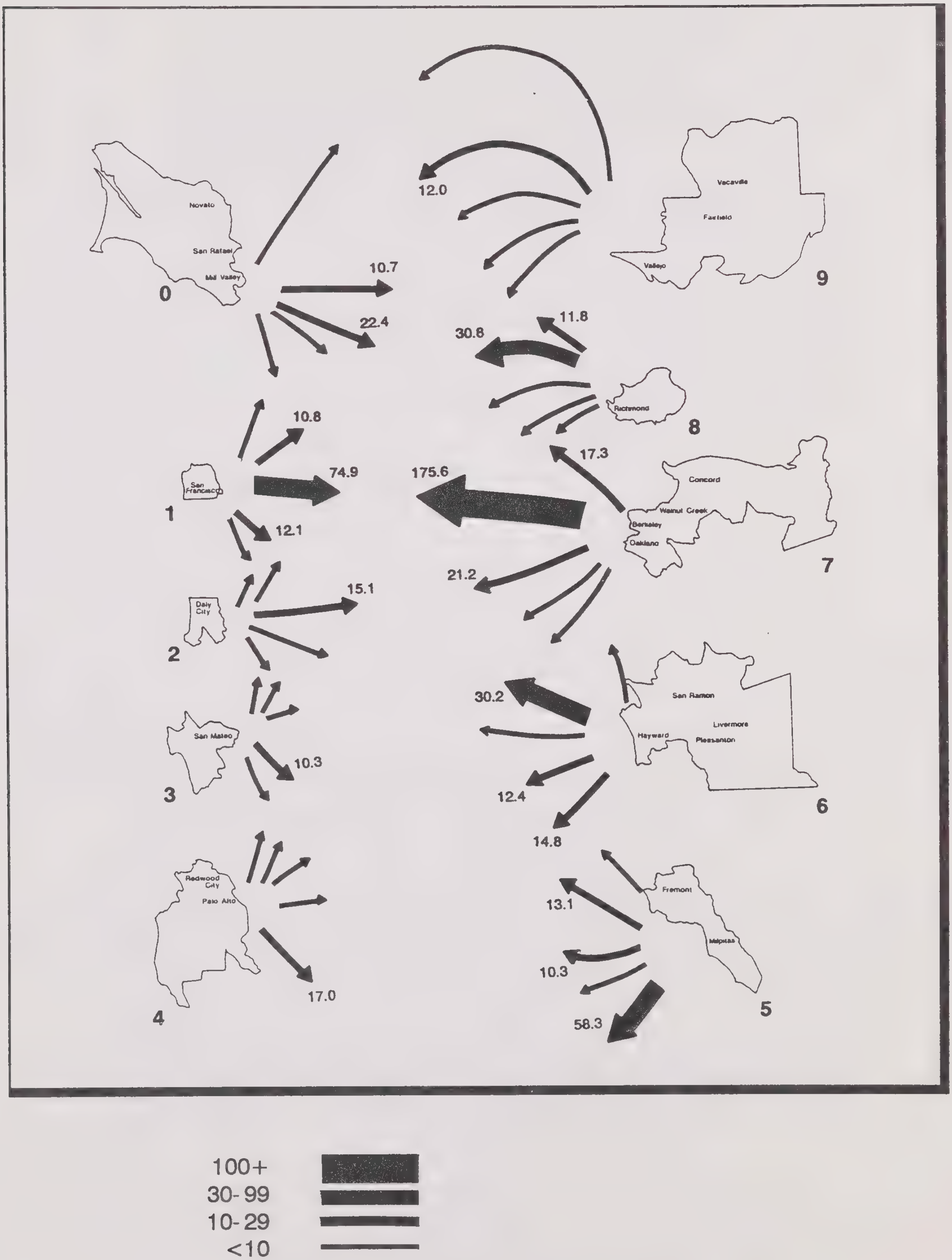
In order to graphically illustrate the relative magnitude of bay crossing trip demand, we have prepared a "spider network" diagram which shows the travel demand along direct paths between each East Bay and West Bay zone, irrespective of the mode or facility used to traverse the Bay. The arrows indicate the relative proportion of two-way trips produced at each of the East Bay or West Bay zones. The volumes, which are shown in all cases where the travel demand exceeds 10,000 daily person trips, represent daily round trips produced from each zone.

The relationships between bay crossing zones, in terms of relative magnitudes of travel, are shown in Figures 2-2 and 2-3. Figure 2-2 shows existing (Year 1987) transbay travel while Figure 2-3 shows future (Year 2010) travel.

Figure 2-2

Transbay Trip Market Existing Total (1987)

Daily Person Trips (in thousands)

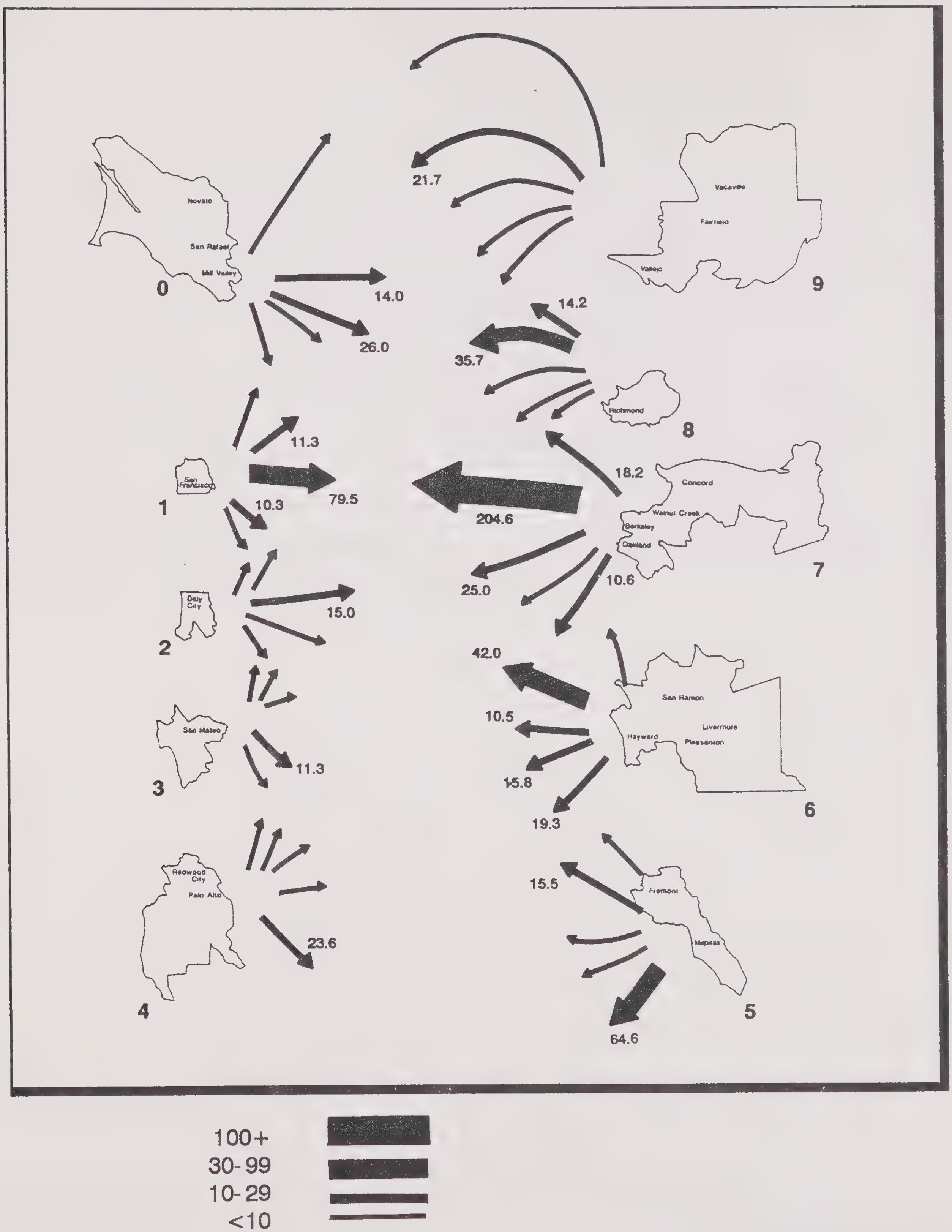


Source: Metropolitan Transportation Commission

Figure 2-3

Transbay Trip Market Future Total (2010)

Daily Person Trips (in thousands)



Source: Metropolitan Transportation Commission

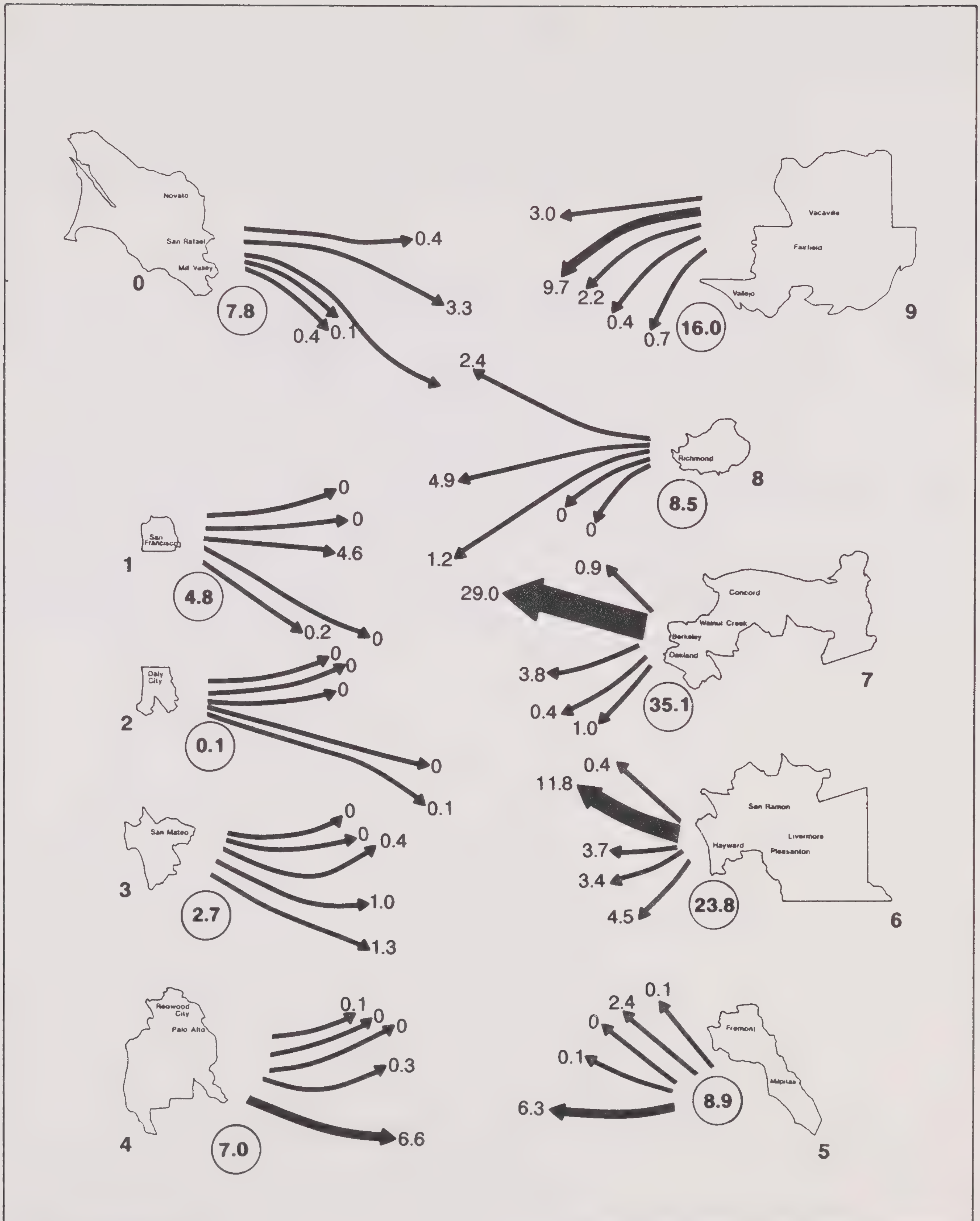
TABLE 2-1
TRANSBAY TRAVEL ZONES

Zone Number	General Location	MTC Superdistrict
0	Marin County	32, 33, 34
1	San Francisco	1, 2, 3, 4
2	Daly City, Pacifica, San Bruno	5
3	San Mateo	6
4	Redwood City, Palo Alto	7, 8
5	Fremont, Milpitas	12, 16
6	Hayward, Pleasanton	15, 17, 23
7	Oakland, Walnut Creek	18, 19, 21, 22, 24
8	Richmond, Crockett	20
9	Solano County	25, 26

For example, the existing interaction between Zone 1 (San Francisco) and Zone 7 (Oakland, Walnut Creek, Concord, etc.) is shown on Figure 2-2. A total of approximately 250,000 daily person trips are made between these two zones. This includes 75,000 daily trips produced in Zone 1 and 175,000 trips produced in Zone 7. For Zone 1 (San Francisco), this data indicates there are 37,500 daily outbound trips made to Zone 7 and 37,500 corresponding daily inbound trips.

These figures illustrate the heavy predominance of San Francisco destinations in today's travel situation and its continued importance in the future. The bay crossing market reflects the overall growth pattern of the Bay Area. Growth in the mid-portion of the Bay Area is slackening, while growth in the perimeter northern and southern zones is increasing.

Figure 2-4 illustrates the growth in transbay travel between the Years 1987 and 2010. The most substantial growth in travel demand is produced from Zones 7 and 8 in the East Bay. The estimated growth in transbay trips produced from these zones is projected to be approximately 35,000 and 24,000 daily person trips, respectively. The greatest increase in transbay travel demand between two zones occurs between Zones 1 and 7, where an additional 34,000 daily person trips are anticipated by the Year 2010.



Korve Engineering, Inc.

Source: Metropolitan Transportation Commission

LEGEND

(heaviest line)	>15
(heavy line)	10-15
(medium line)	5- 9
(thin line)	<5

(23.8) = TOTAL DAILY TRIP ORIGINS

Figure 2-4

Transbay Trip Growth from 1987 to 2010
Daily Round Trips from Producing Zone

(Person-Trips in thousands)

2.2 PRELIMINARY COST PROJECTIONS

The following section presents a discussion of order-of-magnitude construction costs for each of the study alternatives. The alignment for the 11 project alternatives is shown in Figures 2-5 through 2-13 (shown at the end of this section). The basis for the order-of-magnitude cost is outlined below.

Order-of-Magnitude Costs

An order-of-magnitude cost estimate was developed for each of the nine alternative alignments that involve the construction of capital improvements. The following discussion presents the basis of the estimate and a comparison of the order-of-magnitude estimates. These costs were revised for the five alternatives selected for further study and are shown in Section 6.

Table 2-2 provides a summary of the unit cost factors that were applied to generate the order-of-magnitude construction costs. These factors were based upon recent and historical cost data obtained from local transportation agencies as well as information from tunnel and bridge construction projects throughout the United States.

TABLE 2-2
UNIT COSTS FOR ORDER-OF-MAGNITUDE ESTIMATES
1990 Dollars

Facility Type	Range of Unit Costs for Estimate
Ferry Boats	$1 - 3 million per boat
Ferry Terminal Improvements	$5 - 25 million per terminal
Aerial Freeway	$4 - 6 million per lane mile
Trestle Bridge	$5 - 8 million per lane mile
Span Bridge	$10 - 15 million per lane mile
Vehicle Tube/Tunnel	$80 - 100 million per lane mile
Peoplemover Tube/Tunnel	$140 - 150 million per mile
BART Tube/Tunnel	$160 - 170 million per mile
Railroad Tube/Tunnel	$190 - 200 million per mile
Peoplemover Aerial Facility	$20 - 30 million per mile
BART Aerial Facility	$40 - 60 million per mile
BART Subway Facility (Suburban)	$90 - 120 million per mile
BART Subway Facility (Urban)	$170 - 210 million per mile

Note: These unit costs apply to the preliminary cost estimates only. Additional details are provided in the full cost report in Section 6.

Engineering and Management of Construction and Administration

Twenty percent of the total construction cost was added to account for the engineering, construction management, and administrative tasks related to the various facilities.

Contingencies

A general contingency of 30 percent is added to the total construction costs.

Exclusions

For this preliminary discussion of issues, a number of items have been specifically excluded from the order-of-magnitude estimates. The estimates do not include the following elements:

- Right-of-way costs
- Vehicles (rolling stock), except for the High-Speed Ferry Service
- Financing and interest during construction
- Utility agency fees and charges
- Start-up costs for new revenue service
- Retrofit of existing facilities to add new crossing

Comparison of Estimates

Table 2-3 provides a comparison of the estimates for each of the nine capital improvement alternatives.

TABLE 2-3
ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATES[1]

Alternative	Description	Item Cost	Total Cost
1	High-Speed Ferry Service		**$ 0.3 billion**
	- Ferry Boats	$0.15 billion	
	- Terminal Improvements	0.15 billion	
2	Southern Crossing Bridge		$ 2.9 billion
	- Bridge Structure	1.20 billion	
	- Bridge Approaches	1.70 billion	
	BART on Bridge		3.2 billion
	- BART Structure	0.66 billion	**$ 6.1 billion**
	- BART Approaches	2.54 billion	
3	Southern Crossing Tunnel		11.6 billion
	- Tunnel Structure	9.90 billion	
	- Tunnel Approaches	1.70 billion	
	BART in Tunnel		4.4 billion
	- BART Structure	1.86 billion	**$16.0 billion**
	- BART Approaches	2.54 billion	
4	Route 380 to 238 Bridge		1.9 billion
	- Bridge Structure	1.35 billion	
	- Bridge Approaches	0.55 billion	
	BART on Bridge		2.1 billion
	- BART Structure	1.00 billion	**$4.1 billion**
	- BART Approaches	1.10 billion	
5	Route 380 to 238 Tunnel		14.6 billion
	- Tunnel Structure	14.00 billion	
	- Tunnel Approaches	0.60 billion	
	BART in Tunnel		4.1 billion
	- BART Structure	3.00 billion	**$18.7 billion**
	- BART Approaches	1.10 billion	
6	BART Airport Connection Tunnel		**3.8 billion**
	- BART Tunnel	2.30 billion	
7	BART Alameda to Candlestick Tunnel		**4.1 billion**
	- BART Tunnel	2.10 billion	
8	BART Transbay Tube Tunnel		**3.4 billion**
	- BART Tunnel	0.90 billion	

TABLE 2-3 (cont'd)
ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATES[1]

Alternative	Description	Item Cost	Total Cost
9	Airport Peoplemover Tunnel - Peoplemover Tunnel	 2.20 billion	**2.6 billion**
10	Railroad Tunnel - Railroad Tunnel	 3.50 billion	**3.7 billion**
11	Inter-City Railroad Tunnel - Railroad Tunnel	 1.00 billion	**1.8 billion**

[1] The cost for the five alternatives selected for further study were revised and are shown in Section 6.

2.3 IDENTIFICATION OF ISSUES

The following section presents a summary of the key issues relating to each of the 11 alternatives for upgrading transbay mobility. This includes a discussion of environmental concerns, engineering constructability, and order-of-magnitude construction costs.

Baseline Alternative

The baseline scenario for this study is defined as all of those capital and operational improvements that are being considered for inclusion in the 1990 Regional Transportation Plan (RTP). For study purposes, the RTP Environmental Impact Report Alternative 4 "Highway/Transit Blend" (RTP Blend) was selected. Thus, the RTP Blend network was used as a base network to which the bay crossing alternatives were added and the RTP Blend travel performance was used to define a travel baseline against which all bay crossing travel results were judged.

The RTP Blend includes a mix of numerous short- and long-term transportation improvements through the Year 2010, in addition to the short-term projects included in the RTP No-Project alternative. The RTP Blend includes projects described in sales tax expenditure plans approved in Alameda, Contra Costa, San Francisco, San Mateo, and Santa Clara Counties; rail extension projects described in Resolution No. 1876; bridge improvements described in SB 45; the MTC HOV lanes system; and various operational improvements including higher levels of transit service and Caltrans' Traffic Operations System (TOS) to improve freeway flow.

Key highway improvements in the RTP Blend which could affect bay crossing travel include:

- Widening of the San Mateo Bridge causeways from four lanes to six lanes (the high-rise section is six lanes wide already);

- Approach improvements to Dumbarton Bridge approaches including:

    - operational improvements on Bayfront Expressway
    - construction of new SR-109 facility bypassing East Palo Alto
    - construction of new segment of SR-84 between Nimitz and I-238

- Auxiliary/HOV lane widening on Bayshore Freeway from SR-92 to Millbrae Avenue;

- Provision of HOV lane on I-880 from I-238 to San Jose;

- Provision of HOV lane on I-80 from Bay Bridge toll plaza to Carquinez Bridge; and

- Construction of Richmond Parkway between Richmond-San Rafael Bridge and I-80.

Key transit improvements in the RTP Blend which could affect bay crossing travel include:

- BART extensions to East Antioch, San Francisco Airport, East Livermore, and San Jose;

- New AC Transit Route from Richmond BART to Larkspur Ferry/Rail depot operating at 30 minute frequency;

- Construction of the MUNI F-Line extension along the Embarcadero to Fisherman's Wharf;

- Extension of CalTrain to Gilroy and downtown San Francisco; electrification of the system; operation of 156 trains per day;

- Expansion of AMTRAK service between San Jose and Sacramento to 13 daily round trips; maximum speeds increased to 79 MPH;

- Significant improvement in service frequencies and some new bus routes for most of the local bus systems; and

- Provision of ferry services at post-earthquake levels; Vallejo ferry service improved, reducing travel time from 60 to 45 minutes; service frequency of Larkspur ferries increased to ten minutes, and reduction in ferry travel time to San Francisco from 50 to 35 minutes; and new hourly ferry service between Larkspur and Oakland.

Alternative 1: High-Speed Ferry and Operational Upgrade

Alternative terminal sites and routings are shown for the high-speed ferry service on Figure 2-5. These include all of the routes used during post-earthquake service as well as several additional potential routes.

The principal issue relating to the provision of a high-speed ferry service is ability to attract a sustained level of patronage. The number of daily ferry passengers, using *standard ferry boats* at low speeds, increased from 6,300 to approximately 21,000 during the Bay Bridge closure after the October 17, 1989 earthquake. This represented approximately 5 percent of total North Bay/San Francisco trips and 2 percent of total East Bay/San Francisco trips on a daily basis. Since the Bay Bridge has reopened, the total number of ferry passengers has dropped below 8,000 and the number of daily passengers traveling to and from East Bay locations is less than 1,500. Some of the key factors affecting patronage levels are frequency of service, travel times, availability of parking, actual and perceived costs, stability of service, identity of terminals, and the availability of bus connections at the terminals. The level and availability of bus service at the terminals is important since a ferry system offers access to only limited areas along the Bay.

The development of a high-speed ferry system would establish the need to upgrade land-based facilities at the East Bay terminals. Existing terminals are located in Vallejo, Richmond, Berkeley, Emeryville, Oakland, and Alameda where channel depth appears to be adequate to serve high-speed ferries. Additional terminal sites could be provided at locations such as the San Leandro marina, Benicia, Martinez, Crockett, Harbor Bay, and Rodeo. Potential upgrades that may be required at these locations include improvements to access roads as well as the provision of intermodal transfer facilities, dedicated parking areas, covered waiting platforms, better signing, and stations. In addition, the provision of high-speed ferry service would require a review of the effects of the ferry wakes on shoreline activities. The sensitivity to wake effects would vary by site and could be minimized with appropriate vessel design.

The provision of high-speed passenger and/or truck ferry service between the San Francisco and Oakland Airports would require a number of facility improvements similar to those described above. The recently completed Draft Master Plan for San Francisco Airport includes the construction of a new dock at the Seaplane Harbor north of the current runways which could be used for truck ferry service. Additional improvements to North Airport Drive and the provision of

station facilities would be required for the implementation of high-speed passenger service. The suggested location for a ferry terminal at the Oakland Airport is on the south side of Terminal 2.

This area has several environmental constraints including shallow water depths of two to three feet as well as the presence of potential wetland areas and a fuel tank farm. If dredging of the Bay is required, the disposal of spoils materials is an important issue and would involve a permitting process through the Army Corps of Engineers. The development of the shoreline adjacent to Terminal 2 involves wetlands issues. Both marine and avian habitat areas have been identified on and around the airport.

The potential for growth inducement with the implementation of a ferry system appears to be minimal due primarily to land-based facility constraints that could limit system capacity. In addition, the ferry system may have a somewhat limited service area in the East Bay, especially in light of proposed BART expansions.

The order-of-magnitude construction cost for the development of a high-speed ferry system is $0.3 billion. This includes the provision of approximately 30 ferries at a total cost of $150 million. It also includes approximately $150 million of terminal improvements at up to ten locations in the West Bay and East Bay.

Alternative 2: Southern Crossing (Bridge)

The primary issue related to the Southern Crossing is the impact of new freeway facilities on the bridge approaches on local land use and circulation patterns in Alameda, Oakland, San Leandro, San Francisco, and South San Francisco. The Southern Crossing would require a substantial relocation of homes and businesses as well as right-of-way acquisition in each of these communities. In Alameda, the impact would be along the Main Street Corridor and Harbor Bay Drive corridor. The programmed Airport Roadway project through the Oakland Airport is located on the southeast approach corridor to the Southern Crossing; the alignment continues south of the airport to the Davis Street corridor in the City of San Leandro where it connects to Interstate 880 and could connect to a new Route 61 facility. This includes the potential impact on the Oyster Bay Regional Shoreline and the Lew Galbraith Golf Course.

In the West Bay, the Southern Crossing was originally programmed to connect to Interstate 280 to the north via the Hunter's Point Freeway. The planning efforts for a Hunter's Point Freeway were abandoned several years ago. In addition, it is not feasible to provide a new connection to Highway 101 from the Hunter's Point area due to the proximity of existing interchanges along the freeway corridor. A new route to I-280 in this area would be located along the Evans Avenue corridor in Hunter's Point.

The southerly connection in the West Bay would be aligned along the eastern boundary of Candlestick Park, extend to the south, and ultimately curve to connect to the east end of the Guadalupe Canyon Parkway in Brisbane. The construction of this segment of roadway would involve the potential displacement of industrial and housing uses in the Hunter's Point area.

Environmental issues such as the potential impacts on wildlife and air quality are issues to be addressed at the bridge approaches in San Francisco and Alameda. In San Francisco, the bridge approaches intersect the India Basin shoreline and parallel the Candlestick Point State Recreational Area shoreline. The east approaches to the Southern Crossing intersect the Robert Crown Memorial State Beach shoreline in Alameda and the Bay Farm Island shoreline, as well as crossing the San Leandro Channel. The impact of this alternative on regional air quality is also an issue.

The northeast approach leg of the Southern Crossing parallels the southern boundary of the Alameda Naval Air Station. As such, the ability to construct the facility and maintain the proper vertical clearance for the adjacent Air Station runways is an important issue.

The addition of BART to the Southern Crossing generates several issues. The primary alignment issue relates to the difficulty of providing an additional connection at the subway wye in downtown Oakland for a new line that would continue to the southeast through Alameda. The suggested alignment in the East Bay therefore provides a direct southeasterly alignment that connects to the programmed Dublin Extension at its junction with the Fremont line at I-238. This direct connection reduces the need to provide substantial improvements on the Fremont line that would have been required if the new connection to BART had occurred along the existing main line facility. In the West Bay, the BART alignment would continue north to San Francisco along Third Street with a subway connection to the CalTrain Station in Mission Bay. This alignment

provides increased capacity to serve downtown San Francisco, but does not develop additional access or capacity for service to the Peninsula.

The potential for growth inducement appears to be the most substantial with this and other bridge or tunnel alternatives. This is due to the higher capacity that could be provided under this scenario for future transbay travel. This alternative would also potentially create growth pressure for increased density in Alameda residential areas, and in the Candlestick Point area. Some additional growth inducement might be expected along the I-580 corridor due to lower commute times along this corridor to San Francisco and the Peninsula.

The order-of-magnitude construction cost for the Southern Crossing bridge is $6.1 billion. The bridge structure would be approximately 8.3 miles in length. Approximately 40 percent of the $2.9 billion cost for the vehicular portion of the bridge is for the main bridge crossing, while the remaining 60 percent is required to build the approaches to the bridge in the West Bay and the East Bay. The cost of providing BART on this structure is approximately $3.2 billion.

Alternative 3: Southern Crossing (Tunnel)

The ability to construct a vehicle tunnel of this length (approximately 8.3 total route miles) is the primary issue. If constructed, the Southern Crossing tunnel would be one of the longest, if not the longest, vehicular tunnel in the world. The key constraint for a long vehicular tunnel is the ability to provide the necessary level of ventilation for auto and truck emissions. The length of this tunnel would likely require the construction of several mid-tube ventilation shafts in the Bay.

The construction of a Southern Crossing tunnel would generate similar issues as a bridge, based on the impact of new freeway facilities on the tunnel approaches on local land use and circulation patterns in Alameda, Oakland, San Leandro, San Francisco, and South San Francisco. The Southern Crossing would require a substantial relocation of homes and businesses as well as right-of-way acquisition in each of these communities. In Alameda, the impact would be along the Main Street corridor and Harbor Bay Drive corridor. The programmed Airport Roadway project through the Oakland Airport is located on the southeast approach corridor to the Southern Crossing; the alignment continues south of the airport to the Davis Street corridor in the City of San Leandro where it connects to Interstate 880. This includes the potential impact

on the Oyster Bay Regional Shoreline and the Lew Galbraith Golf Course. The impact of this alternative on regional air quality is also an issue.

In the West Bay, the Southern Crossing would be located along the Evans Avenue corridor in Hunter's Point, the Hunter's Point Expressway adjacent to Candlestick Park, and connect to the east end of the Guadalupe Canyon Parkway in Brisbane. The construction of a roadway in this area would involve the potential displacement of industrial and housing uses in the Hunter's Point area.

The addition of BART to the Southern Crossing generates several issues. The suggested alignment in the East Bay provides a direct connection to the programmed Dublin Extension at its connection with the Fremont line. This direction connection reduces the need to provide substantial improvements on the Fremont line that would have been required if the new connection to BART would have occurred north of the proposed connection to the Dublin Extension. The San Francisco alignment is along Third Street with a subway connection to the CalTrain Station in Mission Bay. This alignment provides increased capacity to serve downtown San Francisco, but does not develop additional access or capacity for service to the Peninsula.

The potential for growth inducement appears to be the most substantial with this and other tunnel or bridge alternatives. This is due to the higher capacity that could be provided under this scenario for future transbay travel. This alternative would also potentially create growth pressure in Alameda residential areas for increased density and in the Candlestick Point area. Some additional growth inducement might be expected along the I-580 corridor due to lower commute times along this corridor to San Francisco and the Peninsula.

The order-of-magnitude construction cost for the Southern Crossing tunnel is $16.0 billion. The tunnel structure would be approximately 8.3 miles in length. The cost of providing a vehicular tunnel across the Bay would be significantly higher than a bridge along the same alignment. Approximately 86 percent of the $11.6 billion cost for the vehicular portion of this facility is for the main tunnel crossing, while the remaining 14 percent is required to build the approaches to the tunnel in the West Bay and the East Bay. The cost of providing BART on this structure is approximately $4.4 billion.

Alternative 4: Interstate 380 to 238 Connection (Bridge)

The primary issue related to the Interstate 380 to 238 Connection is the impact of new freeway facilities on the bridge approaches on local land use in San Leandro. The Interstate 380 to 238 Connection would require potential displacement of housing, commercial, and recreational uses as well as right-of-way acquisition in the San Leandro/San Lorenzo vicinity.

Environmental issues such as the potential impacts on wildlife and visual quality are issues to be addressed at the bridge approaches in South San Francisco and San Leandro. In South San Francisco, the bridge approach intersects the shoreline between the Seaplane Harbor at the San Francisco Airport and the South San Francisco/San Bruno sewage treatment plant. The east approaches to the Interstate 380 to 238 Connection intersect the shoreline at Robert's Landing in San Leandro. The potential for creating a land use barrier in San Leandro is another environmental issue. The impact of this alternative on regional air quality may also be an issue. In addition, the East Bay Dischargers Authority "super sewer" is located on an alignment parallel to the East Bay shoreline. The line, dechlorination facility, and outfall are in the vicinity of the bridge alignment. Concern has been raised by San Leandro that the bridge (Alternative 4) would cross the Jack D. Maltester Federal Channel which provides boat access to the Bay from San Leandro Marina.

The west approach leg of the Interstate 380 to 238 Connection crosses the northern boundary of the San Francisco Airport. As such, the ability to construct the facility and maintain the proper vertical clearance for the adjacent runways is an important issue. In the East Bay, the alignment would be clear of the approach slope, but noisy jet aircraft would pass at low elevations over the bridge in the vicinity of both airports. Concern has been raised by San Leandro that jets passing 200-300 feet overhead would be distracting to motorists on the bridge. Preliminary discussions with San Francisco Airport staff indicate that this may not be a key constraint, but additional review will be required upon development of a more detailed alignment and profile.

The addition of BART to the Interstate 380 to 238 Connection raises several issues. In the West Bay, the suggested BART alignment is along Interstate 380, with a connection to the SFO Extension between the programmed Tanforan and Airport stations. In order to provide direct access to the San Francisco Airport from this new crossing, the construction of a new North Airport station is suggested near the connection with South Airport Boulevard; this new station

would connect to the airport via an extension of the Phase II Peoplemover. The proposed BART alignment in the East Bay would involve a direct connection to the programmed Dublin Extension.

The potential for growth inducement appears to be the most substantial with this and other bridge or tunnel alternatives. This is due to the higher capacity that could be provided under this scenario for future transbay travel. A potentially substantial level of growth inducement might be expected along the I-580 corridor due to lower commute times along this corridor to San Francisco and the Peninsula. In addition, growth pressure would be expected in the mid-Peninsula areas due to reduced commute times to the East Bay.

The order-of-magnitude construction cost for the Interstate 380 to 238 Connection bridge is $4.0 billion. The bridge structure would be approximately 11.6 miles in length. Approximately 71 percent of the $1.9 billion cost for the vehicular portion of this facility is for the main bridge crossing, while the remaining 29 percent is required to build the approaches to the bridge in the West Bay and the East Bay. The cost of providing BART on this structure is approximately $2.1 billion.

Alternative 5: Interstate 380 to 238 Connection (Tunnel)

As was the case with the Southern Crossing Tunnel (Alternative 3), the ability to construct a vehicular tunnel of this length (approximately 11.6 total route miles) is the primary issue. If constructed, this tunnel would be one of the longest, if not the longest, vehicular tunnel in the world. The key constraint for a long vehicular tunnel is the ability to provide the necessary level of ventilation for auto and truck emissions. The length of this tunnel would likely require the construction of several mid-tube ventilation shafts in the Bay.

The impact of new freeway facilities on the tunnel approaches on local land use in San Leandro is also a key issue. The Interstate 380 to 238 Connection would require potential displacement of housing, commercial, and recreational uses as well as right-of-way acquisition in this community. In San Leandro, the bridge approach would be located along the Lewelling Boulevard corridor. The potential for creating a land use barrier in San Leandro is another environmental issue. The impact of this alternative on regional air quality is also an issue.

The addition of BART to the Interstate 380 to 238 Connection raises several issues. In the West Bay, the suggested BART alignment is along Interstate 380, with a connection to the SFO Extension between the programmed Tanforan and Airport Stations. In order to provide direct access to the San Francisco Airport from this new crossing, the construction of a new North Airport station is suggested near the connection with South Airport Boulevard; this new station would connect to the airport via an extension of the Phase II Peoplemover. The proposed BART alignment in the East Bay would involve a direct connection to the programmed Dublin Extension.

The potential for growth inducement appears to be the most substantial with this and other tunnel or bridge alternatives. This is due to the higher capacity that could be provided under this scenario for future transbay travel. A potentially substantial level of growth inducement might be expected along the I-580 corridor due to lower commute times along this corridor to San Francisco and the Peninsula. In addition, growth pressure would be expected in the mid-Peninsula areas due to reduced commute times to the East Bay.

The order-of-magnitude construction cost for the Interstate 380 to 238 Connection bridge is $18.7 billion. The tunnel structure would be approximately 11.6 miles in length. The cost of providing a vehicular tunnel across the Bay would be significantly higher than a bridge along the same alignment. Approximately 95 percent of the $14.6 billion cost for the vehicular portion of this facility is for the main tunnel crossing, while the remaining 5 percent is required to build the approaches to the tunnel in the West Bay and the East Bay. The cost of providing BART on this structure is approximately $4.1 billion.

Alternative 6: BART Airport Connection

The construction impacts and cost to build a tunnel under either the San Francisco or Oakland Airport terminals is the primary issue. The key concern is the feasibility of tunneling through the foundation pilings for the terminals. The difficulties associated with construction of a tunnel through the foundation of the South Terminal at the San Francisco Airport is one of the principal reasons that the programmed Airport BART station is located along the west side of Highway 101 rather than in the basement of the short-term parking garage. The process of tunneling under the adjoining runways is also a key issue due to their Bay Mud foundations and pavement thickness (i.e., six feet at the San Francisco Airport). As a result, the proposed BART alignment is located along the boundary of the airports rather than providing a direct connection.

The BART Airport Connection would require potential displacement of housing and commercial uses as well as right-of-way acquisition in this community. In San Leandro, the bridge approach would be located along the Doolittle Drive and the Lewelling Boulevard corridor.

The east approach leg of the BART Airport Connection would be located in an underground tube from the shoreline to the Oakland Airport terminals and in an at-grade or aerial alignment along Airport Drive. As such, the ability to construct the facility and maintain the proper vertical clearance for the adjacent runways at North Field is an important issue.

The potential for growth inducement does not appear to be significant with this scenario as it would not create a significant reduction in commute time, via BART, to San Francisco. It would enhance access to the San Francisco and Oakland Airports, although this is not expected to create increased pressure for growth since people mover systems are already programmed to connect BART to the terminal areas at both airports.

The order-of-magnitude construction cost for the BART Airport Connection tunnel is $3.8 billion. Approximately 61 percent of this cost is for the main tube crossing, while the remaining 39 percent is required to build the approaches to the tube in the West Bay and the East Bay.

Alternative 7: BART Alameda to Candlestick Connection

The principal issue relating to the provision of a BART Alameda to Candlestick Connection is the ability to attract a sufficient level of patronage to justify the cost of the system. The alignment focuses on providing increased service to the San Francisco area. The alignment would not afford the increased operating flexibility that would be produced by developing a loop connection as provided in Alternatives 4 through 6. The alternative results in a second stub-end terminal in the West Bay, similar to the Daly City line, that would have storage and maneuvering needs.

Environmental issues include the potential displacement of retail businesses in Alameda and the impact on the Candlestick Point State Recreational shoreline. The alignment of the new BART tracks through Alameda would be along Webster Street. This alignment could result in construction impacts and/or the related displacement of commercial uses along the corridor in "downtown" Alameda. The west approach of the BART tube would cross the southern portion of the Candlestick Point shoreline, which could result in potential shoreline habitat impacts.

In order to provide a terminus where sufficient storage tracks to support a stub-end terminal could be developed for a reasonable cost, the terminus of the west segment of the proposed BART connection would be located at the existing CalTrain station in Mission Bay. This portion of the line would be located in a subway facility under Third Street. A subway tail track is provided at the end of this segment. This segment of BART could be extended through downtown San Francisco to provide a future connection to an expanded Marin transit system, similar to Alternatives 2 and 3.

The ability to construct a new connection to the BART system at the Oakland wye and the ability to add a fourth subway track through downtown Oakland are the key issues. Based on discussion with BART staff, this would be a costly and technically difficult alternative to design and operate. It may not be possible to extend trackage further south along Broadway in Oakland without completely rebuilding the existing wye.

The potential for growth inducement appears to be minimal with this scenario as it would not provide new access to major employment markets or create a significant reduction in commute time, via BART, to San Francisco. The presence of a new BART station in Alameda could also potentially create growth pressure in residential areas for increased density.

The order-of-magnitude construction cost for the BART Alameda to Candlestick Connection tunnel is $4.1 billion. Approximately 56 percent of this cost is for the main tube crossing, while the remaining 44 percent is required to build the approaches to the tube in the West Bay and the East Bay and to add a fourth subway track through Oakland to the MacArthur BART Station.

Alternative 8: BART Transbay Tube Connection

The principal issue relating to the provision of a BART transbay connection is the ability to attract a sufficient level of patronage to justify the cost of the system. The alignment focuses on providing increased service to the San Francisco area. The alignment would not afford the increased operating flexibility that would be produced by developing a loop connection as provided in Alternatives 4 through 6. The alternative results in a second stub-end terminal in the West Bay, similar to the Daly City line, that would have storage and maneuvering needs.

The potential archaeological and/or historical impacts that would be associated with tunneling under Mission Street in San Francisco on the west approach of the BART transbay tube connection are the potential environmental issues. These issues are typical of areas that have involved historic filling of the San Francisco Bay.

The addition of a second transbay tube, as envisioned in original planning efforts by BART, would require the construction of a fourth subway track through downtown Oakland and construction of a new subway under a segment of Mission Street that would be separate from the existing BART subway under Market Street. The line would curve to the south at Third Street to its terminus at the existing CalTrain Station in Mission Bay. This segment of the line would be located in a subway facility under Mission and Third Streets. A tail track is provided at the end of this segment. This new segment could be extended south to provide a future BART line along the existing CalTrain route to San Jose.

The development of increased capacity in the transbay tube would potentially be growth inducing as it would provide shorter commute times to the major employment center in San Francisco. It could generate increased pressure for growth along the corridors of the BART extensions in the East Bay and create a greater demand for parking at associated stations.

The order-of-magnitude construction cost for the BART transbay tube connection tunnel is $3.4 billion. Approximately 25 percent of this cost is for the main tube crossing, while the remaining 75 percent is required to build the approaches to the tube in the West Bay and the East Bay.

Alternative 9: Airport Peoplemover Connection

The principal issue relating to the provision of a peoplemover service is the ability to attract a sufficient level of patronage to justify the cost of the system. The BART transbay tube currently serves approximately 26 million passengers per year. A recent proposal for the Airport Peoplemover Connection suggests that the facility would capture all of the 3 million annual passenger trips made by East Bay residents going to San Francisco International Airport and all of the 300 daily truck trips made between the two airports. These optimistic projections of patronage represent approximately 12 percent of the total annual trips served by the BART transbay tube.

The primary environmental issue is the potential impact on wetlands and the sensitive shoreline habitat located adjacent to the Oakland Airport and Oyster Bay Regional Shoreline in the East Bay during construction. The Airport Peoplemover Connection would parallel the shoreline along the south boundary of the Oakland Airport.

The construction impacts and cost to build a tunnel under either the San Francisco or Oakland Airport terminals is another key issue. As noted earlier, the key concern is the feasibility of tunneling through the foundation pilings for the terminals. The difficulties associated with construction of a tunnel through the foundation of the South Terminal at the San Francisco Airport is one of the principal reasons that the programmed Airport BART station is located along the west side of Highway 101 rather than in the basement of the short-term parking garage. The process of tunneling under the adjoining runways is also a key issue due to their Bay Mud foundations and pavement thickness (i.e., six feet at the San Francisco Airport). This constraint indicates that the alignment of a peoplemover connection, as it crosses the shoreline, might have to be located around the periphery of the two airports rather than connecting directly to the terminals.

The compatibility of a transbay peoplemover system with those currently programmed for both airports is another key issue. In order to provide the reduced travel times necessary to attract patrons, the new automated peoplemover would have to employ higher capacity vehicles that would operate at speeds in excess of 30 miles per hour. This type of system may not be compatible with the low speed, local access systems that are currently planned for the airports.

Two different types of people mover technology could be applicable for this system. The first would be smaller vehicles (four to six passengers) that would operate at very short headways. The second option would be larger vehicles (40 passengers or more) that could provide a much greater capacity. It should be noted that peoplemover systems would have operational costs as they do not require drivers and the smaller vehicles are generally less sophisticated than BART vehicles.

The proposed design for the peoplemover system shows separate systems for people, baggage, and freight. The baggage and freight would be handled on conveyor systems. The ability to construct a conveyor of this length is a design issue to be reviewed. An alternative design would

provide separately designated vehicles to accommodate baggage and freight on the same track as passenger vehicles.

The relationship between the operation of the proposed peoplemover connection and the FAA mandated security systems currently in place represent the final unresolved issue. If the peoplemover is designed to operate within the security system as proposed, only ticketed passengers would be allowed to ride by the FAA. This would result in a limited market for patrons of the peoplemover system. An alternative would be to design the peoplemover to operate as an external system which could be connected to the adjacent BART stations and capture a larger share of patronage.

The potential for growth inducement appears to be minimal due to the limited service area and the limited capacity that would be provided during the peak commute hours in comparison to other alternatives. It would enhance access to the San Francisco and Oakland Airports, although this is not expected to create increased pressure for growth since peoplemover systems are already programmed to connect BART to the terminal areas at both airports.

The order-of-magnitude construction cost for the peoplemover tunnel is $2.6 billion. Approximately 86 percent of this cost is for the main tunnel crossing, while the remaining 14 percent is required to build the approaches to the tunnel in the West Bay and the East Bay.

Alternative 10: Railroad Airport Connection

The primary issue for a railroad airport connection is the limitations in locating a facility due to restrictive alignment criteria, such as a maximum allowable mainline grade of 1 percent. As a result of these limitations, it would be prohibitively costly and disruptive to realign Highway 101 in order to construct a railroad tunnel that provides a direct link to the airports. This is particularly due to constraints at the San Francisco Airport where a direct connection to the main Southern Pacific Line immediately west of Highway 101 is difficult to achieve. The revised alignment therefore provides a connection between existing railroad spurs near the San Leandro and South San Francisco shorelines. The alignment of this railroad crossing in the West Bay does not allow for direct access, via transfer, to BART or other area transit services.

The primary environmental issue is the potential impact on wetlands and the sensitive shoreline habitat located between the Oakland Airport and Oyster Bay Regional Shoreline during construction. The Railroad Airport Connection would parallel the shoreline along the south boundary of the Oakland Airport.

Another issue is the difficulty of providing the necessary level of ventilation for standard diesel railroad equipment emissions. As such, the proposed system utilizes electrified railroad equipment to avoid significant ventilation structure needs. The installation of an electrified train system in the railroad tunnel would require either a modification of existing rail systems (e.g., CalTrain) or a change of engines at route junctions.

This alternative is not expected to be growth inducing within the immediate Bay Area because the short-range commuter service to San Francisco from the East Bay could be provided in a more frequent and cost-effective manner via BART. This facility would provide access to San Francisco and the Peninsula for planned inter-city railroad service that would connect Sacramento and San Jose. As such, additional pressure for growth might be expected along the I-80 corridor to Sacramento.

The order-of-magnitude construction cost for the Railroad Airport Connection is $3.7 billion. Approximately 97 percent of this cost is for the main tunnel crossing, while the remaining 3 percent is required to build the approaches to the tunnel in the West Bay and the East Bay.

Alternative 11: Inter-City Railroad Connection

This facility would provide access to San Francisco and the Peninsula for planned Inter-City Railroad service that would connect Sacramento and San Jose. It provides a more direct link than that established with Alternative 10. The railroad tunnel crossing, as shown in Figure 2-13, would be approximately 3.3 miles in length as opposed to the 12 mile tunnel required in Alternative 10.

As with Alternative 10, the difficulty of providing the necessary level of ventilation for standard diesel railroad equipment emissions is a key issue. As such, the proposed system utilizes electrified railroad equipment to avoid significant ventilation structure needs. The installation of

an electrified train system in the railroad tunnel would require either a modification of existing rail systems (e.g., CalTrain) or a change of engines at route junctions.

The primary environmental issue is the potential impact of dredging for construction purposes near the Outer Harbor Terminal at the Port of Oakland. This alternative is not expected to be growth inducing within the immediate Bay Area because the short-range commuter service to San Francisco from the East Bay could be provided in a more frequent and cost-effective manner via BART. This facility would provide access to San Francisco and the Peninsula for planned Inter-City Railroad service that would connect Sacramento and San Jose. As such, additional pressure for growth might be expected along the I-80 corridor to Sacramento.

The order-of-magnitude construction cost for the Inter-City Railroad Connection is $1.8 billion. Approximately 55 percent of this cost is for the main tunnel crossing, while the remaining 45 percent is required to build the approaches to the tunnel in the West Bay and the East Bay.

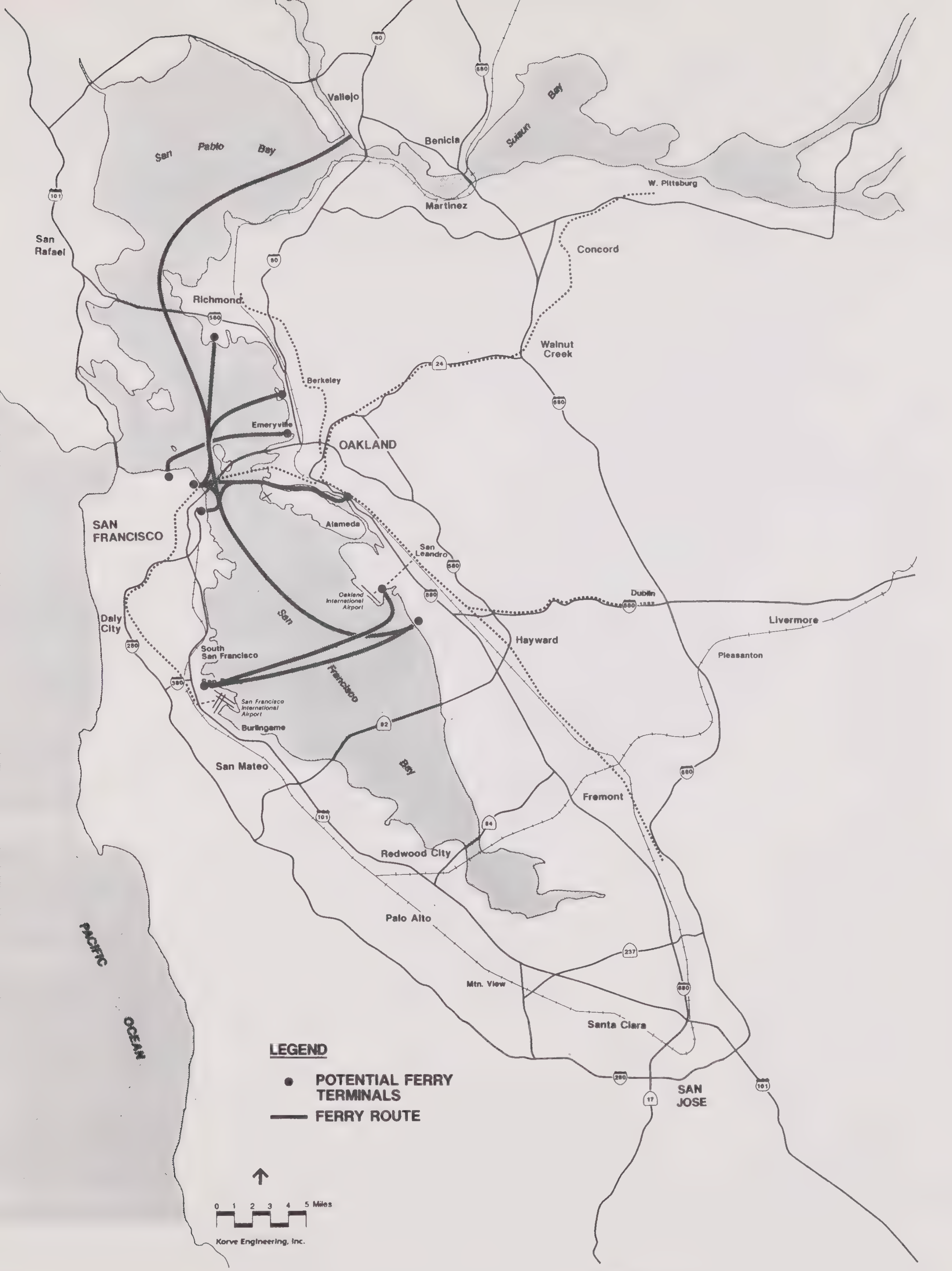


Figure 2-5

ALTERNATIVE 1
HIGH-SPEED FERRY

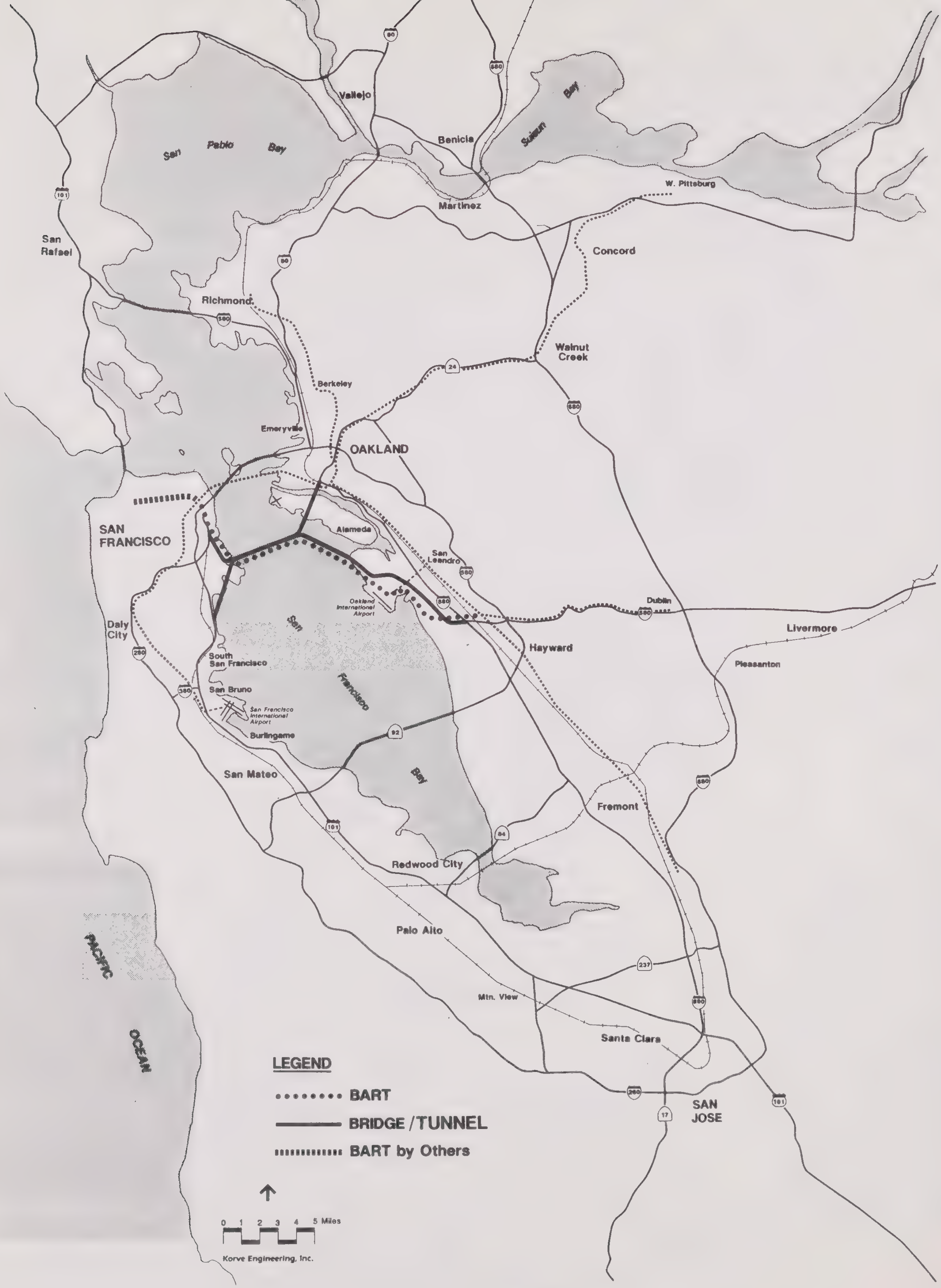


Figure 2-6

ALTERNATIVES 2 & 3

BRIDGE & TUNNEL - SOUTHERN CROSSING

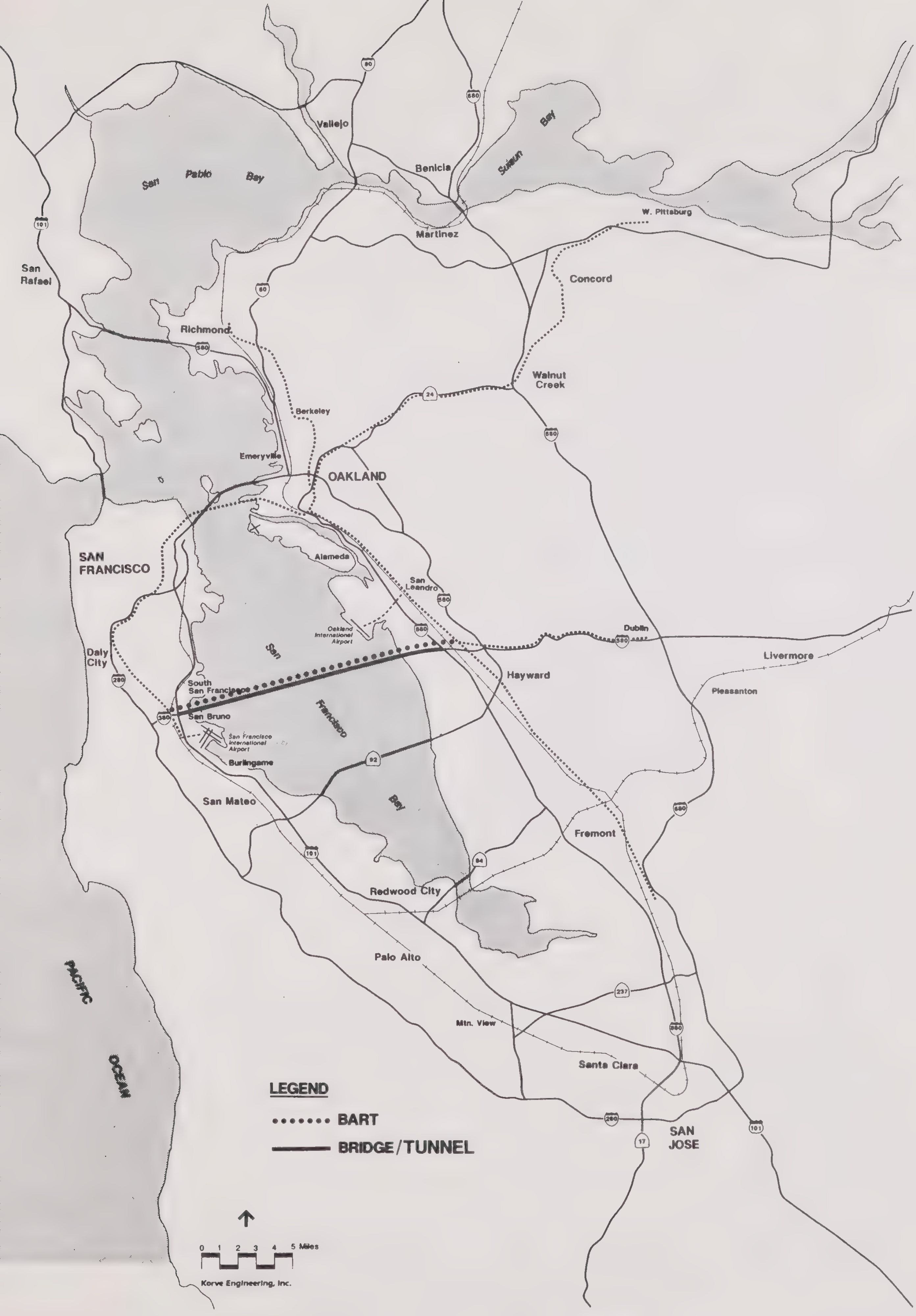


Figure 2-7

ALTERNATIVES 4 & 5

BRIDGE & TUNNEL - I-380 TO I-238

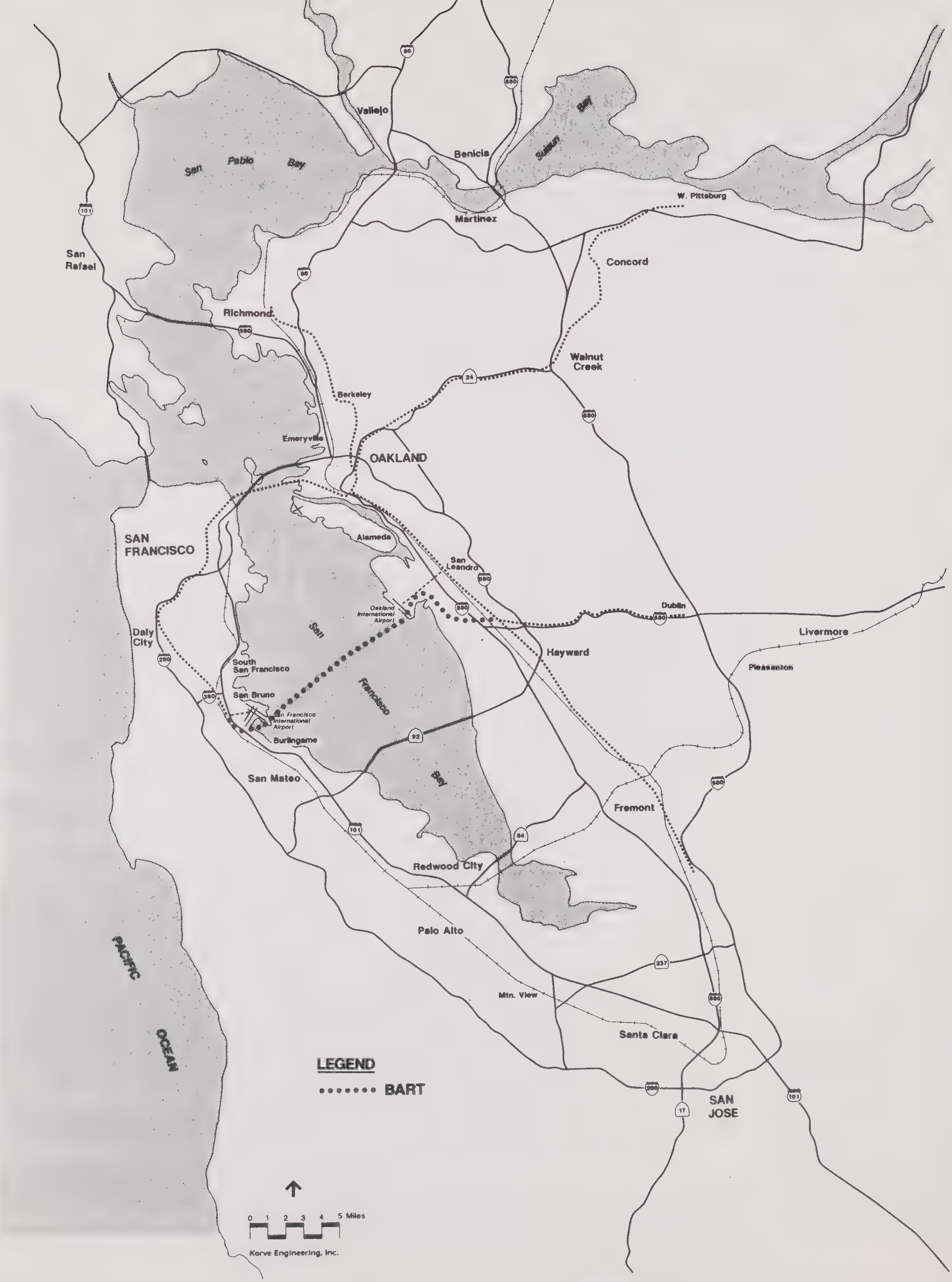


Figure 2-8

ALTERNATIVE 6

TUNNEL - BART AIRPORT CONNECTION

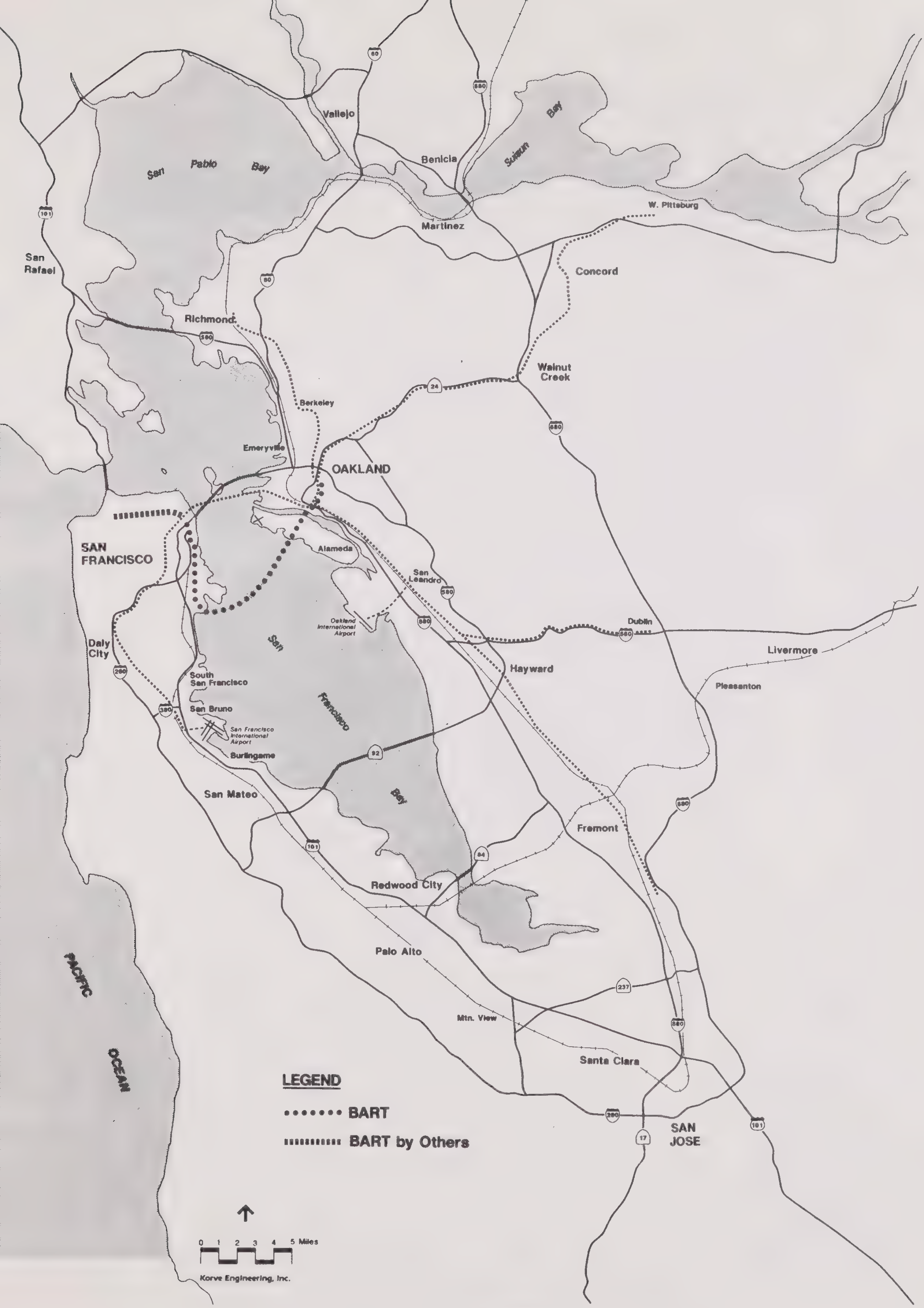


Figure 2-9

ALTERNATIVE 7

TUNNEL - BART ALAMEDA TO CANDLESTICK

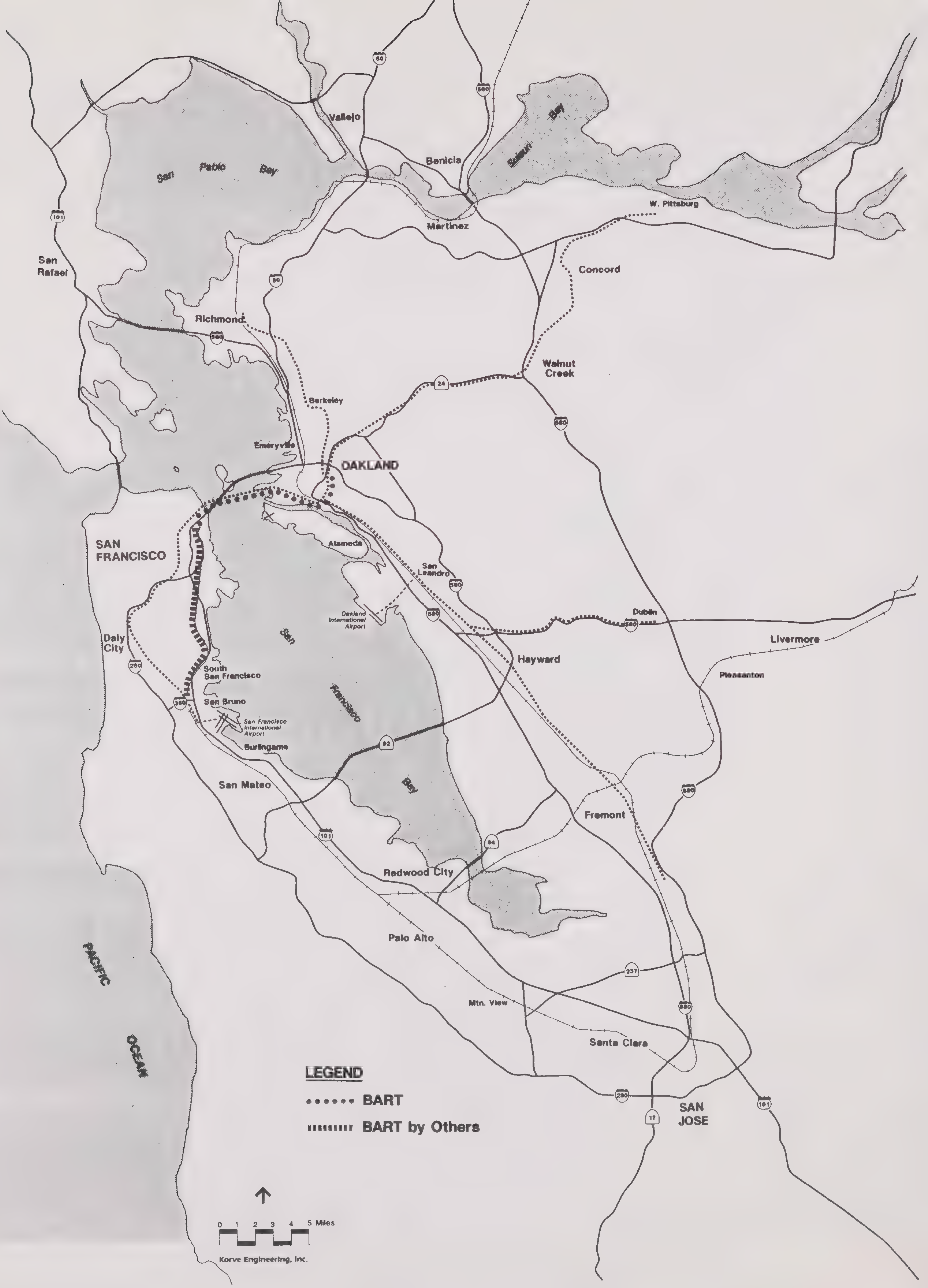


Figure 2-10

ALTERNATIVE 8

TUNNEL - BART TRANSBAY TUBE

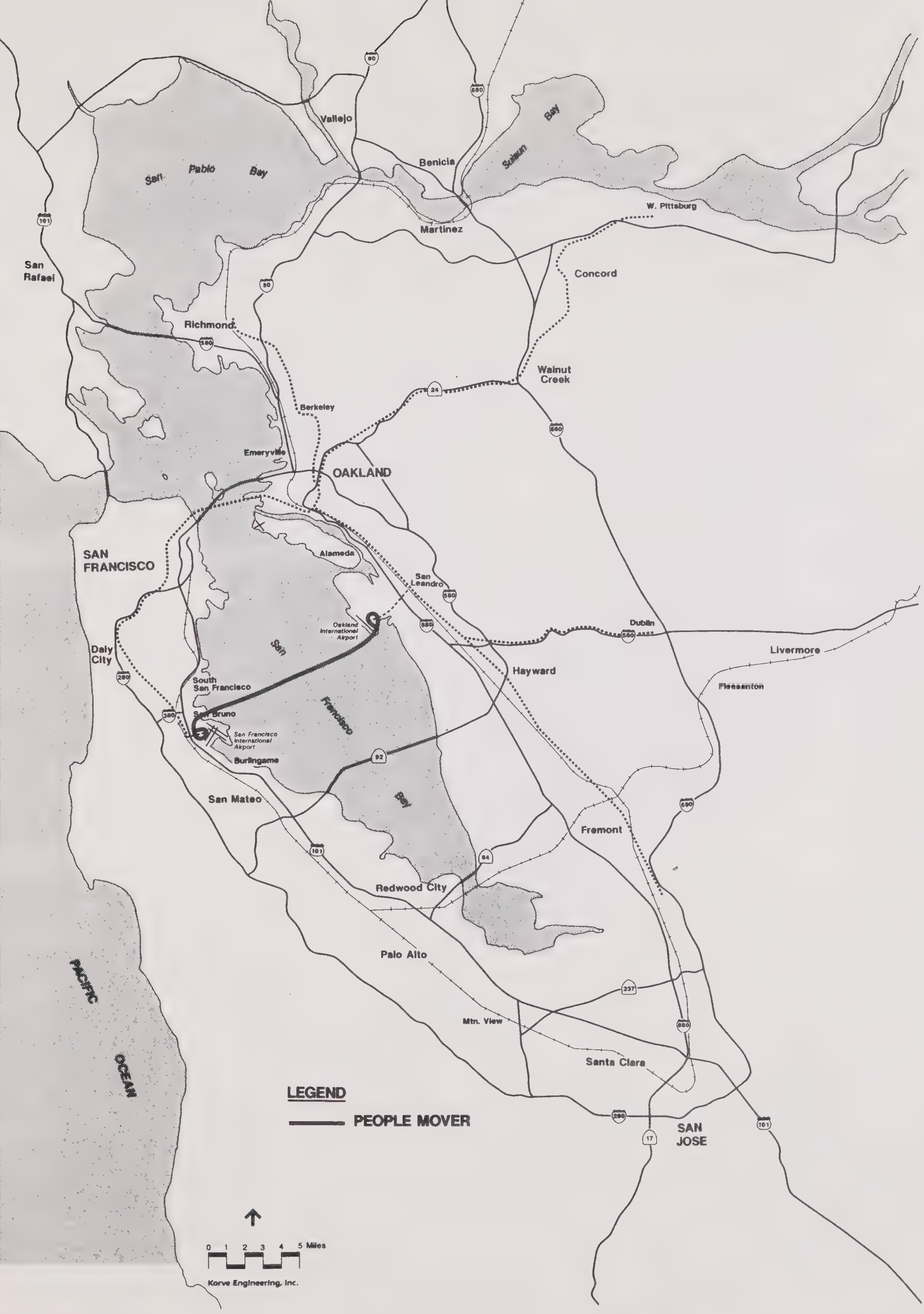


Figure 2-11

ALTERNATIVE 9

TUNNEL - PEOPLEMOVER

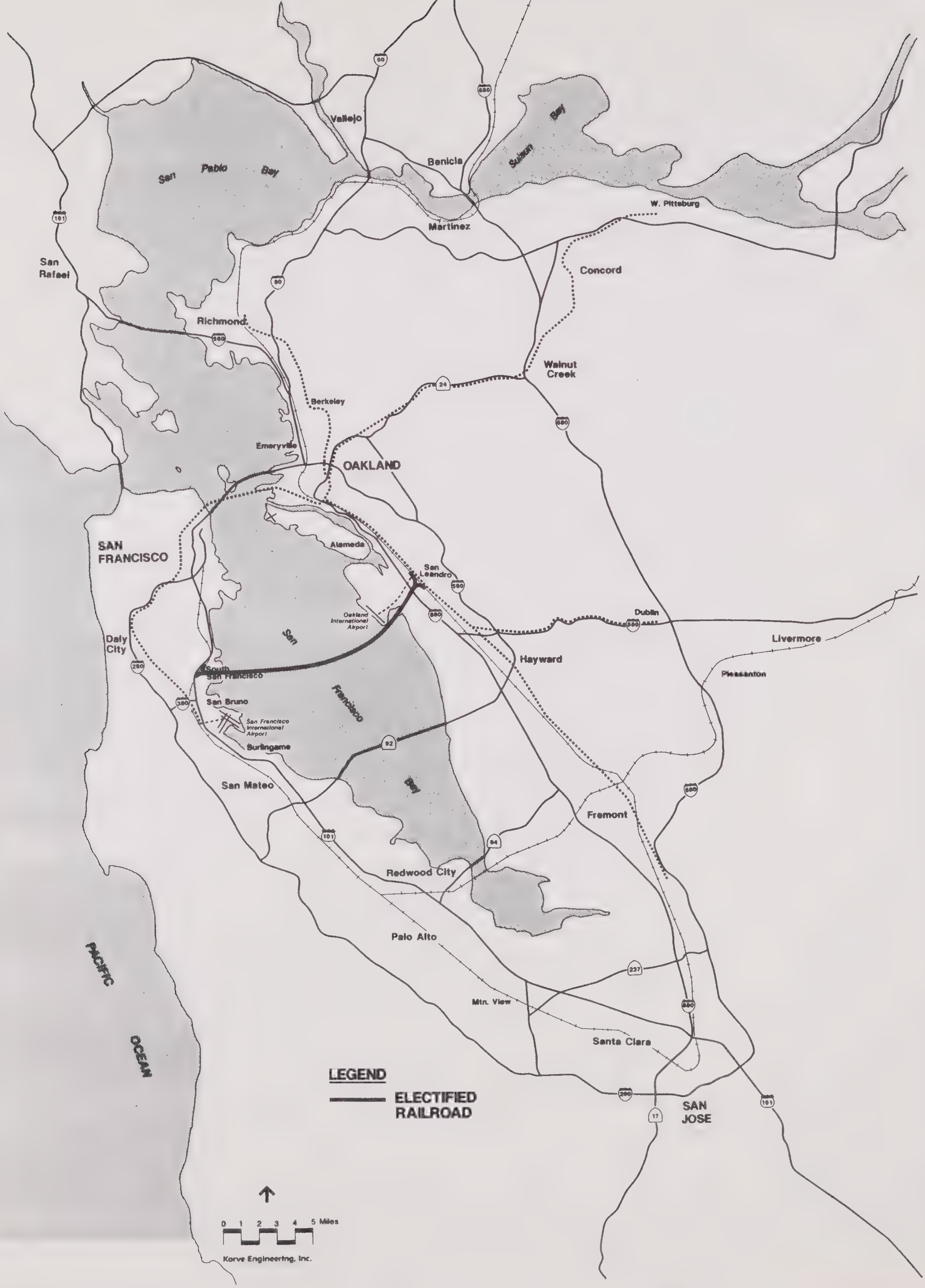


Figure 2-12

ALTERNATIVE 10

TUNNEL - ELECTRIFIED RAILROAD

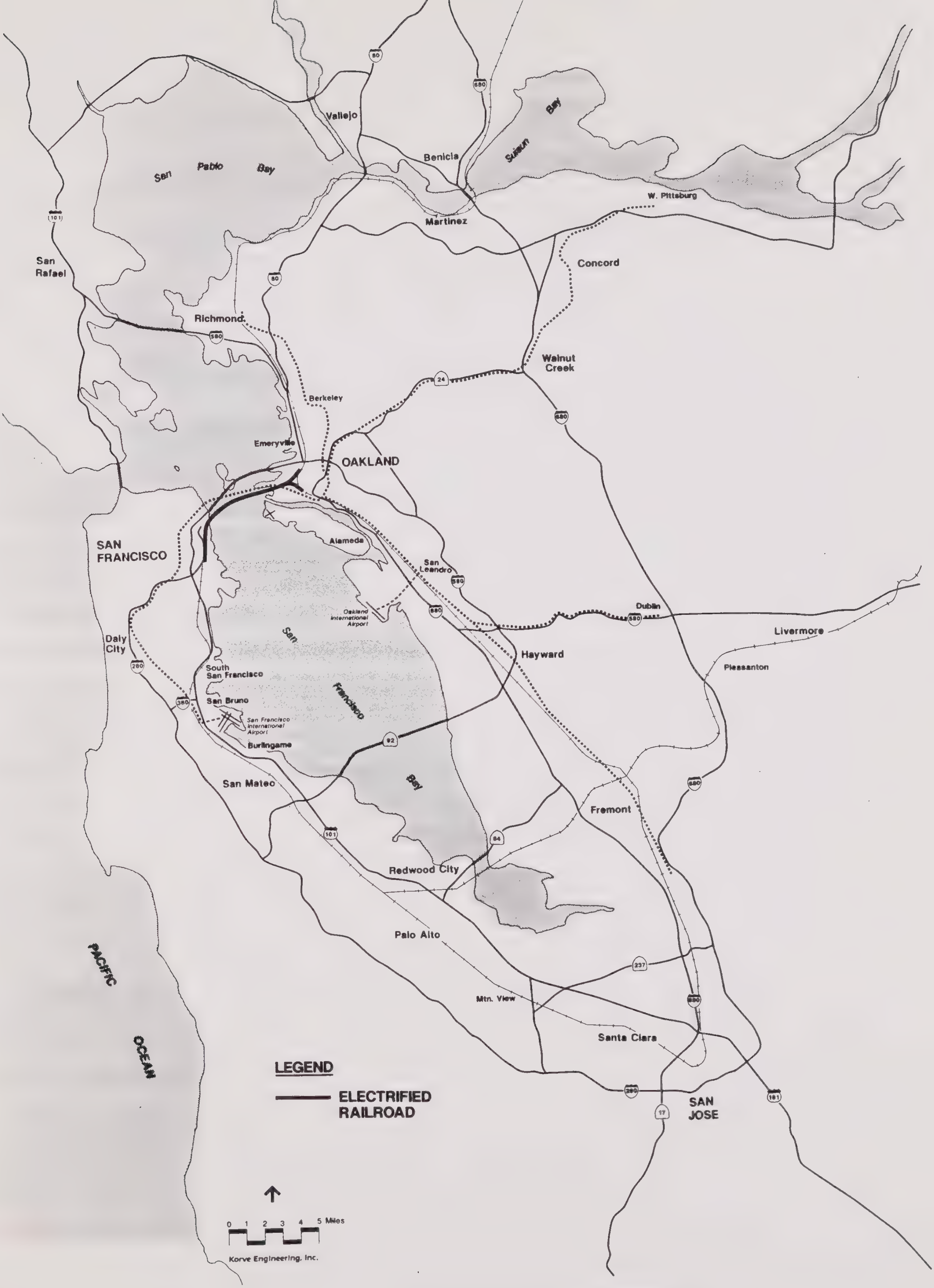


Figure 2-13

ALTERNATIVE 11

TUNNEL - INTER-CITY RAILROAD

3. FINAL ALTERNATIVES

SECTION 3
FINAL DEFINITION OF ALTERNATIVES

3.1 INTRODUCTION

The purpose of this chapter is to provide more detailed information on the physical and operating characteristics of each of the five alternatives identified for further study. The selection of the five final alternatives was made by the Policy Committee based upon input by MTC staff, the Technical Committee, the general public, and the consulting team. Several alignment alternatives were suggested for Alternatives 4 and 6 during public hearings.

The following chapter provides both written and visual depictions of the five final alternatives for use in the subsequent alternatives analysis. The general alignment criteria that are used for new bridge and tunnel facilities is described. This includes a summary of criteria such as maximum allowable grades, minimum curve radius, and station alignments. These criteria are outlined for highway, BART, and railroad facilities.

The definition of the five final alternatives is designed to provide additional information on the horizontal and vertical alignment, the location of any new stations or terminals, and the operating characteristics of each alternative. The alignments of the four alternatives that involve either a new bridge or tunnel are shown in figures that identify a preliminary plan and profile (included at the end of this section).

The high-speed ferry alternative is also defined. This includes a description of the proposed system, route alignments, terminal locations, transit times, and boat types. It also includes a discussion of a potential truck ferry service between San Francisco and Oakland International Airports.

A bike/pedestrian facility is assumed in the concept design for the highway bridge. It may be possible to design such a facility to meet requirements for disabled access, however, this level of design detail was not considered in this study. All transit alternatives would be accessible to disabled persons per current state and federal law.

3.2 GENERAL ALIGNMENT CRITERIA

This section presents a description of general alignment criteria that were applied in developing the preliminary horizontal and vertical profiles for the four alternatives involving either new bridge or tunnel facilities. These criteria are outlined separately for highway, BART, and railroad facilities.

Highway Facility

The construction of a new bridge connecting Interstate 380 and Interstate 238 is the key component of Alternative 4, which represents the one option that includes a new highway crossing of San Francisco Bay. Alternative 4 also includes the provision of rail facilities for a BART connection between the West Bay and the East Bay along this corridor. The following general alignment criteria were adopted for preparation of the preliminary plan and profile. The criteria are more restrictive than those typically applied to highway facilities due to the presence of BART, which must adhere to stricter guidelines on the bridge structure.

- Maximum allowable grade: 3 percent
- Minimum operating curve radius: 3,000 feet
- Minimum length of vertical curves: change in grade x 100
- Minimum bridge clearance above channel: 140 feet
- Minimum vertical BART clearance: 13 feet
- Grade at BART stations should be on tangent
- Minimum spacing between BART tracks: 30 feet on centers on bridge

  20 feet on centers on aerial structure

Facility

Three of the final five alternatives include a new extension of BART across San Francisco Bay, either in conjunction with a bridge as described above for Alternative 4 or as an independent system. Alternatives 6 and 8 are based on new transbay BART tubes located along the present tube alignment near the Bay Bridge or providing a connection between the San Francisco and Oakland Airports, respectively. The following general alignment criteria were adopted for preparation of the preliminary plan and profile.

- Maximum allowable grade: 3 percent
- Minimum operating curve radius: 3,000 feet
- Minimum length of vertical curves: change in grade x 100
- Minimum vertical BART clearance: 13 feet
- Grade at BART stations should be on tangent
- Minimum spacing between BART tracks: 30 feet on centers on bridge
20 feet on centers on aerial structure

Railroad Facility

Alternative 11 involves the construction of a new tunnel for Inter-City Railroad service connecting the Southern Pacific rail yards in San Francisco and the Union Pacific rail yards adjacent to the Port of Oakland's Middle Harbor Area.

- Maximum allowable grade: 3 percent
- Maximum desirable grade: 2 percent
- Minimum operating curve radius: 3,000 feet

- Minimum length of vertical curves: change in grade x 100

- Minimum vertical railroad clearance: 30 feet

3.3 DEFINITION OF ALTERNATIVES

The following section presents information on the horizontal and vertical alignment, the location of any new stations or terminals, and the operating characteristics of each of the five final alternatives. The alignment for the four alternatives that involve new bridge or tunnel structures is described for three different segments: West Bay, transbay, and East Bay.

Alternative 1: High-Speed Ferry and Operational Upgrade

A viable passenger ferry system for the San Francisco Bay crossing will consist of several integrated components, including:

- State-of-the-art ferry boats with capacities and speeds to match passenger and route demands

- Adequate water access to landing terminals

- Conveniently located ferry terminals designed for rapid loading and unloading of passengers

- Sufficient auto parking facilities to meet passenger demand

- Convenient intermodal terminal transfer points for feeder buses and trains

- Feeder network adequate to provide convenient, dependable service between ferry terminals and passengers' destinations

Proposed Routes

Proposed routes were selected on the basis of current travel patterns, the location of currently overburdened transportation facilities, and the viability of individual ferry terminal locations. In addition, only transbay routes were selected in accordance with the goals of this study. The viability of terminal locations was determined by using maps, navigation charts, and personal visits to potential sites.

The resulting proposed routes are shown on Figure 3-1. All routes include stops at either two or three terminals (typically, San Francisco and one or two others). Proposed ferries travel at 30 knots between terminals, with 10 minute stops at the terminals. Times between ferries are 15 minutes during commute hours and 30 minutes at other times. Non-stop service is provided between terminals during commute hours, while multiple stops on routes are established during off-peak hours. Proposed routes for transbay passenger ferries are summarized below.

A. Benicia - Martinez - San Francisco
B. Vallejo - Rodeo - San Francisco
C. Richmond - Berkeley - San Francisco
D. Alameda - Oakland - San Francisco
E. Bay Farm Island - San Francisco
F. San Leandro Marina - San Francisco
G. Oakland Airport - San Francisco Airport
H. Redwood City - San Leandro Marina
I. San Leandro Marina - Coyote Point
J. San Leandro Marina - Oyster Point

While all of these routes were studied, the travel analysis indicated very low patronage levels on many of the routes. Therefore, prior to the final evaluation, a reduced ferry system consisting of the top five routes was identified. The revised alternative included the following routes:

A. Vallejo - San Francisco
B. Rodeo - San Francisco
C. Richmond - San Francisco
D. Alameda - San Francisco
E. Bay Farm Island - San Francisco

Based on the above routes, passenger travel times calculated for each route are tabulated in Table 3-1. Travel times using 20 knot ferries are also included for comparison. All routes include stops at either two or three terminals (typically, San Francisco and one or two others). Proposed ferries travel at 30 knots between terminals, with 10 minute stops at each terminal. Times between ferries are 15 minutes during commute hours and 30 minutes at other times.

TABLE 3-1
FERRY PASSENGER TRANSIT TIMES

Route	To San Francisco From:	Stops	Speed 30 Knots	Speed 20 Knots
A	Benicia	no	60	90
	Benicia	Martinez	73	105
	Martinez	no	60	90
B	Vallejo	no	53	79
	Vallejo	Rodeo	64	90
	Rodeo	no	44	66
C	Richmond	no	17	24
	Richmond	Berkeley	31	41
	Berkeley	no	15	21
D	Oakland	no	14	21
	Oakland	Alameda	25	31
	Alameda	no	11	17
E	Bay Farm Island	no	17	25
F	San Leandro Marina	no	29	42
G	Oakland Airport to San Francisco Airport	no	20	30
H	Redwood City to San Leandro Marina	no	23	34
I	San Leandro Marina to Coyote Point	no	23	34
J	San Leandro Marina to Oyster Point	no	20	30

Note: Transit time is given in minutes from departure to arrival.

In most cases, the travel times using 30 knot boats compare favorably with times for competing modes of transport. Thus, if effective feeder facilities are available at the terminals, the system can compete with other forms of transbay transport.

Terminal Locations

Proposed ferry terminal locations were chosen to provide the best compromise among the many contributing factors. The key factors that were assessed in the analysis of potential ferry terminals are described below.

1. Exposure to weather
2. Water depth
3. Environmental impact
4. Existing docking and terminal facilities
5. Proximity to patrons

Based on these factors, 17 locations are proposed for ferry terminals. Proposed terminal locations, also shown on Figure 3-1, are listed below.

- Benicia
- Martinez
- Vallejo
- Rodeo
- Richmond
- Berkeley
- Oakland
- Alameda
- Bay Farm Island
- Oakland Airport
- San Leandro Marina
- Redwood City
- San Francisco Airport
- Oyster Point
- Coyote Point
- Mission Bay (Pier 24)
- SF Ferry Building

Terminal improvements will be required at each of the above locations to accommodate a high-speed ferry system across the San Francisco Bay. The size of the terminals will range from one acre to five acres, depending upon the type of parking facility (i.e., at-grade vs. structures) and level of terminal amenities that are provided. The typical terminal facility will have the following land side terminal needs.

1. Docking Facilities: to integrate vessel and dock facilities to provide safe, fast passenger loading and unloading in all tidal conditions. The typical example is a simple pier, with access facilities to accommodate many types of vessels.

2. <u>Terminal Facilities:</u> to provide passenger waiting areas, protection from weather, ticket selling and collecting, and other services.

3. <u>Parking Facilities:</u> to provide facilities similar to those at BART stations with capacities ranging from 500 to 1,000 stalls. At many of the above locations, these facilities would take the form of parking structures due to limited land availability.

4. <u>Intermodal Transfer Facilities:</u> to provide an interface with mass transit feeder systems serving adjacent residential or commercial areas.

5. <u>Access Roads:</u> to provide access to the parking and intermodal facilities. At many of the above locations, roads must be built or improved to provide access from adjacent freeway facilities.

6. <u>Loading Pier:</u> long-span piers may be constructed in shallow depth waters to provide access from the shoreline to deep waters for conventional ferry boats.

<u>Ferry Boat Types</u>

Catamaran type vessels with 400 passenger capacity and 30 knot speed are proposed for all routes. The provision of peak hour service at 15 minute headways would require a fleet of 80 to 100 boats to service the 17 ferry terminal locations. Enhanced access would be provided on all new vessels for both pedestrians and bicyclists. Such vessels are presently being used on San Francisco Bay and elsewhere with high success. Possible exceptions to the use of catamarans are as follows.

1. As a mitigation to dredging the shallow water at the Oakland Airport, the use of a hovercraft vessel will be studied.

2. If analysis show that 30 knot speeds are not required to compete with alternate forms of transportation on some routes, conventional monohulls may provide a lower cost alternative.

Truck Ferry Service

A ferry service transporting light trucks between San Francisco and Oakland Airports has been suggested as a means to alleviate congestion on transbay bridges. This service would differ from passenger service in many respects: larger ferries with large open-deck vehicle space would be required, specially designed docks and ramps would be necessary for loading and unloading, and speed and schedule requirements would be different for responsive, economical operation.

The truck ferries would be of a single hull boat type that typically travel at lower speeds than the multi-hull vessels. The capacity of the boats vary, although a truck ferry of similar size to standard passenger ferries could accommodate up to 20 large trucks. Large truck ferries are used in the Seattle area to cross the waters of the Puget Sound; these boats are several hundred feet long with trucks on a lower level and a deck house on the upper level.

Water depth limitations is a major consideration shared by both proposed passenger and light truck services at the Oakland Airport. Possible solutions to this concern are described as follows.

1. Increase channel depth and width to accommodate conventional single hull, displacement type ferries.

2. Construct a loading pier into deep water for the conventional ferries.

3. Use amphibious hovercraft type vessels in place of conventional ferries.

Alternative 4: Interstate 380 to 238 Bridge Connection

This option involves the construction of a bridge connecting Interstate 380 in the West Bay to Interstate 238 in the East Bay. The proposed bridge has an eight-lane cross-section that includes HOV lanes. (Year 2010 traffic demand could be satisfied with a four-lane bridge, and a "revised" alternative which would provide a reduced-width deck with provision for BART was also costed out and evaluated.) A bike/pedestrian facility with connections to the ring around the Bay trail is assumed in the concept design. The bridge would be an orthotropic structure in

the main span with trestle bridges on each approach (e.g., similar to the San Mateo-Hayward Bridge). The options for bridge types in the main span are limited as it is located immediately north of the San Francisco Airport and structure heights would be restricted by FAA regulations. This eliminates such options as the cable-stayed bridge. BART is incorporated in the bridge structure to provide rail service along the Interstate 380 to 238 corridor. The alignment of the proposed alternative is shown in Figures 3-2 through 3-4.

The operating characteristics of the proposed bridge are described both for vehicular and rail traffic. The design speed for vehicular traffic is 70 miles per hour (mph), with a suggested posted speed of 55 mph. The toll facility for vehicles will be located on the East Bay segment between the shoreline and the Southern Pacific Railroad right-of-way. The BART facility consists of two tracks located on the lower level of a double deck bridge structure that spans the north-south shipping channel and in the center of the trestle bridge on both approaches. The new BART crossing would be designed for speeds of up to 80 mph and headways of 2.5 minutes.

West Bay Segment

The highway element of the West Bay segment connects to Interstate 380 at the freeway-to-freeway interchange with Highway 101. This interchange could accommodate a future connection from Interstate 380 through to the east and across San Francisco Bay. Currently, Interstate 380 is a six-lane freeway with auxiliary lanes between Highway 101 and Interstate 280. Single lane ramps connect the North Access Road for San Francisco Airport, which is along the alignment of Interstate 380 between Highway 101 and the shoreline, with Highway 101. As such, the provision of HOV access from Highway 101 to the new bridge would require the reconstruction of these grade-separated ramps to provide exclusive transit lanes.

The highway approach to the bridge would be at grade between Highway 101 and the shoreline along the alignment of the North Access Road. At the shoreline, the elevation of the highway would rise to meet the elevation of a trestle bridge located approximately 15 feet above the Bay.

The BART SFO Extension project will extend the current service on the San Francisco Peninsula from Daly City/Colma to the San Francisco Airport along the San Bruno branch of the Southern Pacific Railroad right-of-way. The BART approach to the bridge would provide a connection to and from the north on the BART SFO Extension, tieing in to the at-grade tracks just north of the

proposed Tanforan station. It would also allow for a future connection to and from the south should BART service be extended down the Peninsula.

The BART connection to the bridge would be on an aerial structure that would span the Southern Pacific Railroad right-of-way, Highway 101, South Airport Boulevard, the Colma Creek, and the San Bruno Canal. A new elevated station would be located at South Airport Boulevard, providing a connection to San Francisco Airport via an extension of the Phase II Peoplemover from the United Airlines maintenance area. The BART approach would then connect to a trestle bridge at the shoreline located approximately 15 feet above the Bay.

Transbay Segment

The transbay segment is composed of a main span bridge over the north-south shipping channel and low-level trestle bridges connecting the span bridge to the West Bay and East Bay. The profile of the main span bridge, which provides 150 feet of clearance over the shipping channel, is shown in Figure 3-3. The BART tracks are located on the lower level of the double deck bridge structure spanning the shipping channel, while the vehicular lanes are located on the upper level.

The trestle bridges, which are located at an elevation approximately 15 feet above the Bay, would be a single level structure with the BART tracks in the center and the vehicle lanes on the outer portion. The provision of additional clearance for small boat access under the trestle bridge near the East Bay shoreline will be assessed in subsequent cost studies. At the shoreline of the West Bay approach, the BART tracks and vehicle lanes are located on separate trestle structures. The junction of these two trestle bridges occurs approximately 4,000 feet from the shoreline. At this point, the westbound vehicle lanes would be elevated on a grade-separated structure. This allows the BART line to cross under the westbound lane into the center of the trestle bridge with no change in elevation.

East Bay Segment

The highway element of the East Bay segment connects to Interstate 238 just east of the freeway interchange of Interstate 880 and Washington Avenue. This interchange is designed to accommodate a future freeway-to-freeway connection between Interstates 880 and 238.

The highway approach to the bridge would be a grade-separated structure, beginning at Hesperian Boulevard, that would span over the Washington Avenue overpass at Interstate 880. Currently, partial directional access is provided from Interstate 880 to Interstate 238. The extension of Interstate 238 to the west would be accompanied by the construction of a full freeway-to-freeway interchange at the junction with Interstate 880.

On the west side of Interstate 880, the highway would transition to an at-grade facility along the Manor Boulevard alignment. Approximately 2,000 feet east of the Southern Pacific Railroad, the elevation of the highway would rise to provide an overpass that would span the railroad, continue along the Estudillo Canal Level, and connect with the trestle bridge. The railroad overpass would be designed to accommodate the construction of an interchange to provide access to any future roadway (Route 61) that might be constructed along the railroad corridor.

The BART Dublin/Pleasanton Extension will provide a new connection from the Fremont line at Interstate 238 in an easterly direction along the Interstate 580 corridor to Pleasanton. The new BART line will be located primarily in the median of Interstate 580. The new line will include both at-grade and grade-separated segments.

The BART approach to the bridge would provide a direct connection from the Dublin/Pleasanton Extension to and from the west along the Interstate 238 corridor. A new transfer station would be provided at the junction of the Fremont and Dublin/Pleasanton lines due to the difficulty in providing full connections between the two lines. The primary constraint in providing a new interchange between the two lines is the disruption to existing revenue service (i.e., closure during construction) that would result from constructing new connections to the aerial tracks on the Fremont line located on the south side of Interstate 238. A full connection at this junction would also be prohibitively costly due to the skewed angle at which these lines cross and the level of development in close proximity to the crossing.

At the transfer station, the Dublin/Pleasanton line station would be an elevated facility located above a new Fremont line station. The BART approach to the bridge would continue to the west in the median of Interstate 238. At Hesperian Boulevard, the BART line would connect with the highway approach to the bridge and follow the same alignment. A second new station would be provided at the Southern Pacific Railroad overpass.

An alternative East Bay alignment, as shown in Figure 3-4 as Alternative 4A, would be located to the south of the study alternative along the San Lorenzo Creek. This corridor, located along the border of San Leandro and San Lorenzo, was suggested as an option that might result in lower costs and less significant environmental impacts. Subsequent discussion with Caltrans indicated that this alignment was a more circuitous route than the study alternative and had been previously studied in the 1960s. As such, this study will focus on the main study alternative alignment as shown in Figure 3-4. Additional information on the relative cost and environmental impacts of Alternative 4A are provided in Sections 5 and 6. These alignments represent two of many possible corridors in the East Bay (for example, a third alignment has been suggested along Grant Street in San Lorenzo) that would be analyzed in more detail if this alternative is selected for further study.

Alternative 6: BART Airport Connection

This alternative involves the construction of a tunnel for BART tracks in a mid-bay alignment connecting the San Francisco and Oakland International Airports. The proposed tunnel would provide for two tracks and a utility corridor in the center of the tube. The alignment of the proposed alternative is shown in Figures 3-5 through 3-9. The new BART crossing would be designed for speeds of up to 80 mph, headways of 2.5 minutes, and 24 hour operation. An alternative route suggested during the public hearing process is an alignment which travels west along the Dublin-Pleasanton extension, then turns north along the existing Fremont line, turning west along the Hegengerger Road corridor, tunnels under the Oakland Airport, crosses the Bay on a rail bridge, tunnels under the San Francisco Airport, and connects with the SFO extension in the West Bay. This alignment, along with other alternatives, could be considered for more detailed assessment if further studies are conducted for this alternative.

West Bay Segment

The BART SFO Extension project will extend the current service on the San Francisco Peninsula from Daly City/Colma to the San Francisco Airport along the Southern Pacific Railroad right-of-way. The approach to the BART tube would provide a connection to and from the north on the BART SFO Extension, tieing in to the at-grade tracks just south of the proposed San Francisco International Airport station. It would also allow for a future connection to and from the south should BART service be extended down the Peninsula. South of the Airport BART station, the

BART tracks would transition into a tunnel and cross Highway 101 in a subway facility under the Millbrae Avenue interchange. The BART tracks would continue to descend, connecting to the tunnel structure at the shoreline on the south side of the San Francisco International Airport.

Transbay Segment

The BART tube would descend from the West Bay approach at a 3 percent grade in order to be below the 45 feet deep shipping channel that is located approximately 2,300 feet east of the shoreline in the West Bay. Upon clearing the shipping channel, the tube would ascend at a 3 percent slope to a depth approximately 50 feet below the existing bay bottom. The tube would then parallel the bay bottom until reaching the shoreline in the East Bay.

East Bay Segment

In a fashion similar to Alternative 4, the East Bay BART line will tie into the Dublin/Pleasanton Extension at the junction of the Fremont line and Interstate 238. The BART approach to the tunnel would provide a direct connection from the Dublin/Pleasanton Extension to and from the west along the Interstate 238 corridor. A new transfer station would be provided at the junction of the Fremont and Dublin/Pleasanton lines due to the difficulty in providing full connections between the two lines. As discussed previously, the primary constraint in providing a new interchange between the two lines is the disruption to existing revenue service that would result from constructing new connections to the Fremont line located on the south side of Interstate 238. A full connection at this junction would also be prohibitively costly due to the skewed angle at which these lines cross and the level of development in close proximity to the crossing.

At the transfer station, the Dublin/Pleasanton line station would be an elevated facility located above a new Fremont line station. This would involve construction of an east-west upper platform over the existing north-south platform, requiring a special engineering design for the vertical movement of passengers. The BART approach to the airport would continue to the west in the median of Interstate 238.

At Hesperian Boulevard, the BART line would "fly over" the existing Washington Boulevard overpass and continue in an aerial structure west to the Southern Pacific Railroad corridor. The aerial BART structure along this corridor would be located adjacent to several schools. At the

railroad corridor, the BART tracks would turn north along the railroad right-of-way and continue as an aerial facility. A new station would be provided along this route at Marina Boulevard in San Leandro. North of Williams Street to Davis Street, the tracks would be located at-grade.

Approximately 1,000 feet north of Davis Street, the BART tracks would transition to an elevated structure and cross over Doolittle Drive. The tracks would then curve to the west and parallel the south side of Airport Drive along the approach to the Oakland International Airport. The BART tracks would transition first to an at-grade facility and then into a subway facility approximately 1,000 feet east of the loop road serving the two airport terminals. A new subway station would be provided under the existing parking facility with underground connections to both terminals. The BART tracks would then turn to the south and descend into the BART tube.

The development of a BART station at the Oakland Airport would generate the need to provide a separate parking facility due to the limited availability of parking at the airport. As a result, it is suggested that structured parking be constructed above the existing surface lots at the south terminal to provide a facility for BART patrons. Fees would be charged for non-BART patrons that are compatible with existing airport parking rates for short-term use.

Alternative 8: BART Transbay Tube Connection

The construction of a second tube along the alignment of the existing BART tube would provide increased capacity for service between San Francisco and the East Bay. The proposed tunnel would provide for two tracks and a utility corridor in the center of the tube. The alignment of the proposed alternative is shown in Figures 3-10 and 3-11. The new BART crossing would be designed for speeds of up to 80 mph, headways of 2.5 minutes, and 24 hour operation.

The West Bay alignment of the second transbay tube connection would incorporate three new subway stations in downtown San Francisco. The alignment would cross the shoreline under Mission Street and curve to the west in an alignment along Post Street. The initial station under Mission Street would parallel the existing Embarcadero station and would be linked by a pedestrian tunnel. The second station would be under the existing Montgomery Street station, forming a joint terminal. The third station would be a Union Square terminal under Post Street. The route would terminate at a stub end station just west of Leavenworth Street. This alignment

represents one of many possible options through San Francisco that could be analyzed in more detail if this alternative is selected for further study.

In the East Bay, a fourth track would be provided through downtown Oakland between the MacArthur station and the West Oakland station. This system would provide increased capacity through the Oakland wye by allowing BART to operate the Richmond and Concord transbay lines in the existing tube and the Fremont and future Dublin transbay lines in the new, parallel tube.

West Bay Segment

The BART alignment in San Francisco would involve the construction of subway facilities that would cross the shoreline under Mission Street and curve to the west in an alignment along Post Street. The west end of the alignment would be a subway stub end tail track located between the Union Square station and Leavenworth Street. This would allow for a future connection either to the north (e.g., Marin County) along the Geary Street corridor.

The West Bay segment would have three new stations in downtown San Francisco. The initial station under Mission Street would parallel the existing Embarcadero station and would be linked by a pedestrian tunnel. The second station would be under the existing Montgomery Street station, forming a joint terminal. The third station would be a Union Square terminal under Post Street.

Transbay Segment

The BART tube would descend from the West Bay approach at a 2 percent grade to a depth of approximately 125 feet in order to be below the deepest bay waters that are located approximately 8,000 feet east of the San Francisco shoreline. Upon clearing these deep waters, the tube would ascend to a depth approximately 50 feet below the existing bay bottom. The tube would then parallel the Bay bottom until reaching the shoreline in the East Bay.

East Bay Segment

The BART approach in the East Bay would parallel the existing route between the shoreline and the West Oakland station, bypass the Oakland "wye" in a subway facility, connect to the system

again at the 12th Street station as a new fourth subway track, and continue along this alignment to the MacArthur station. No new stations would be provided through downtown Oakland, although modifications to existing stations at West Oakland, 12th Street, and 19th Street would be required to accommodate the addition of new service along a fourth subway track.

The BART tracks would be in a subway facility between the shoreline and the Maritime Street overpass. The tracks would transition to an aerial structure east of the Maritime Street overpass, providing two additional tracks at the elevated West Oakland station. At Martin Luther King, Jr. Way, the BART tracks would begin a transition to the subway facility through downtown Oakland. The new fourth track would bypass the Oakland wye that is located immediately east of this transition area and connect to the system again at the 12th Street station.

Alternative 11: Inter-City Railroad Connection

The final alternative involves the construction of a tunnel connecting rail service in the East Bay and West Bay. The proposed tunnel would provide for two tracks and an emergency/utility corridor in the center of the tube. The alignment of the proposed alternative is shown in Figures 3-12 and 3-13. The new railroad crossing would be designed for speeds of up to 80 mph and minimum headways of 5 minutes.

The proposed tunnel is also designed to accommodate transbay freight service to both the Port of San Francisco and the Port of Oakland. This requires the construction of a tunnel with an inside vertical clearance of 30 feet to accommodate double-stack trains, which is almost 50 percent greater than the clearance of 21'-6" that is being provided for passenger service on the CalTrain Extension to Market Street.

<u>West Bay Segment</u>

The railroad connection would terminate at the proposed CalTrain station at Fifth Street, located in a subway facility under the existing Southern Pacific rail yard, adjacent to Townsend Street in San Francisco. This would provide a connection to the future CalTrain service into downtown San Francisco, which will be located in a subway facility between China Creek and Market Street. The railroad connection would transition from the Fifth Street subway station at a 2 percent downward slope towards the San Francisco shoreline.

Transbay Segment

The railroad tube would descend from the West Bay approach at a 2 percent grade to a depth of approximately 125 feet in order to be below the deepest bay waters that are located approximately 8,000 feet east of the San Francisco shoreline. Upon clearing these deep waters, the tube would ascend to a depth approximately 50 feet below the existing bay bottom. The tube would then parallel the bay bottom until reaching the shoreline in the East Bay. The railroad tube would connect to the shoreline at the western end of the Union Pacific Railroad yards at the Port of Oakland.

East Bay Segment

The connection of the railroad tube to the shoreline along the Union Pacific Railroad right-of-way would require the construction of a long transition area in order to allow the tube to clear the shipping channel for the Outer Harbor at the Port of Oakland. The portal for the transition to the tube would be located approximately 2,500 feet east of the shoreline. The East Bay railroad approach would then be in an at-grade alignment along the Union Pacific Railroad corridor.

To the east of the portal, the railroad would split to allow for access both to the north (e.g., Sacramento Valley) and to the south (e.g., East Bay, San Jose, etc.). The northerly leg would require the use of a connection from the Union Pacific Railroad, via an existing railroad corridor through the Oakland Naval Supply Center, to the Southern Pacific "Desert Yard" on the north side of Seventh Street. The north leg would cross Seventh Street at the existing grade-separated structure located east of the Maritime Street overpass.

The south leg of the railroad approach would continue along the Union Pacific Railroad corridor and require a new connection between the Union Pacific Railroad and the Southern Pacific Railroad that parallels the Oakland Inner Harbor in a north-south alignment. A grade-separated overpass would be provided at the entrance to the Port of Oakland's Middle Harbor area.

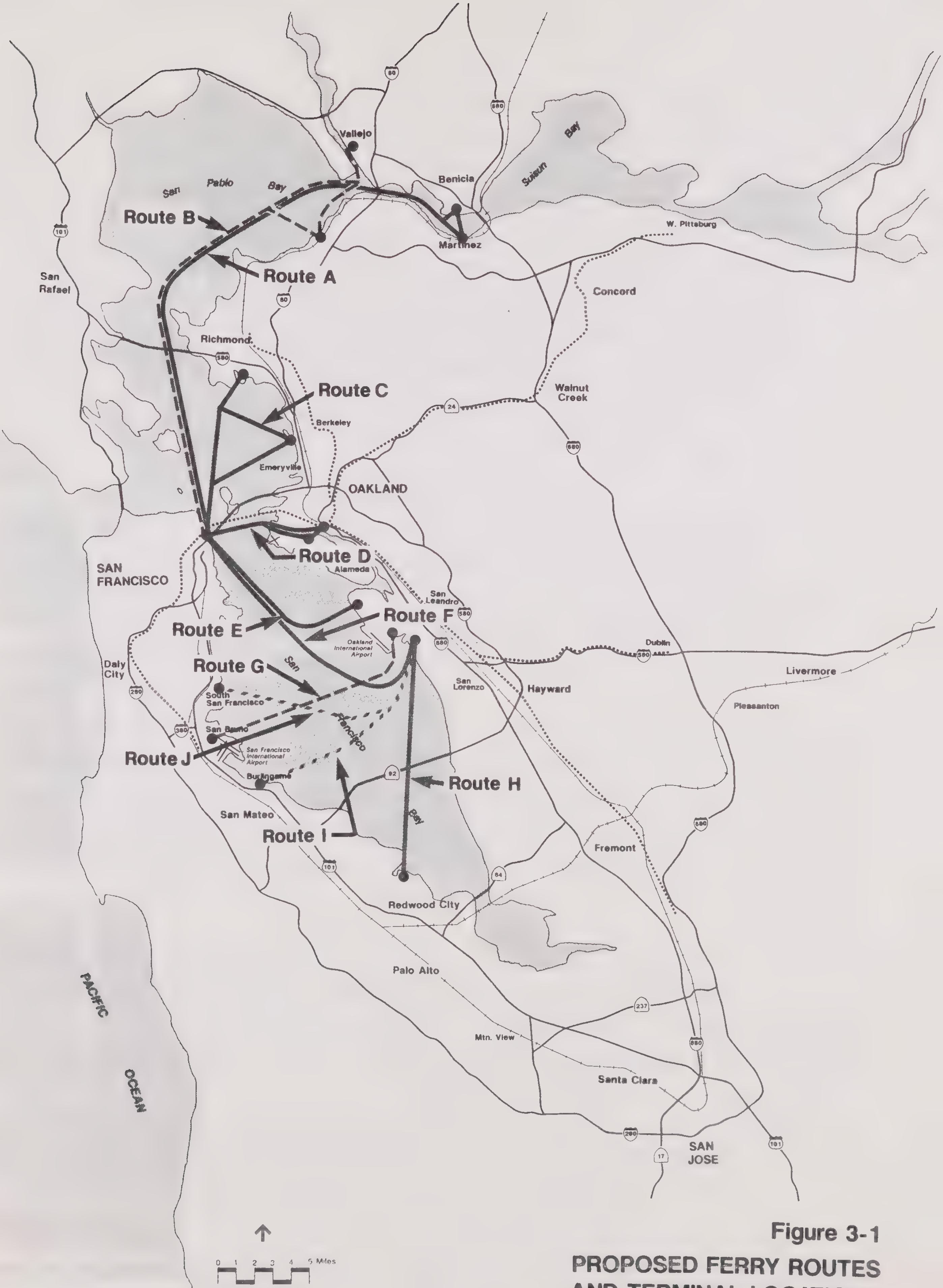


Figure 3-1

PROPOSED FERRY ROUTES AND TERMINAL LOCATIONS

Figure 3-2
Alternative 4
- Interstate 380 to 238 Bridge
West Bay Segment

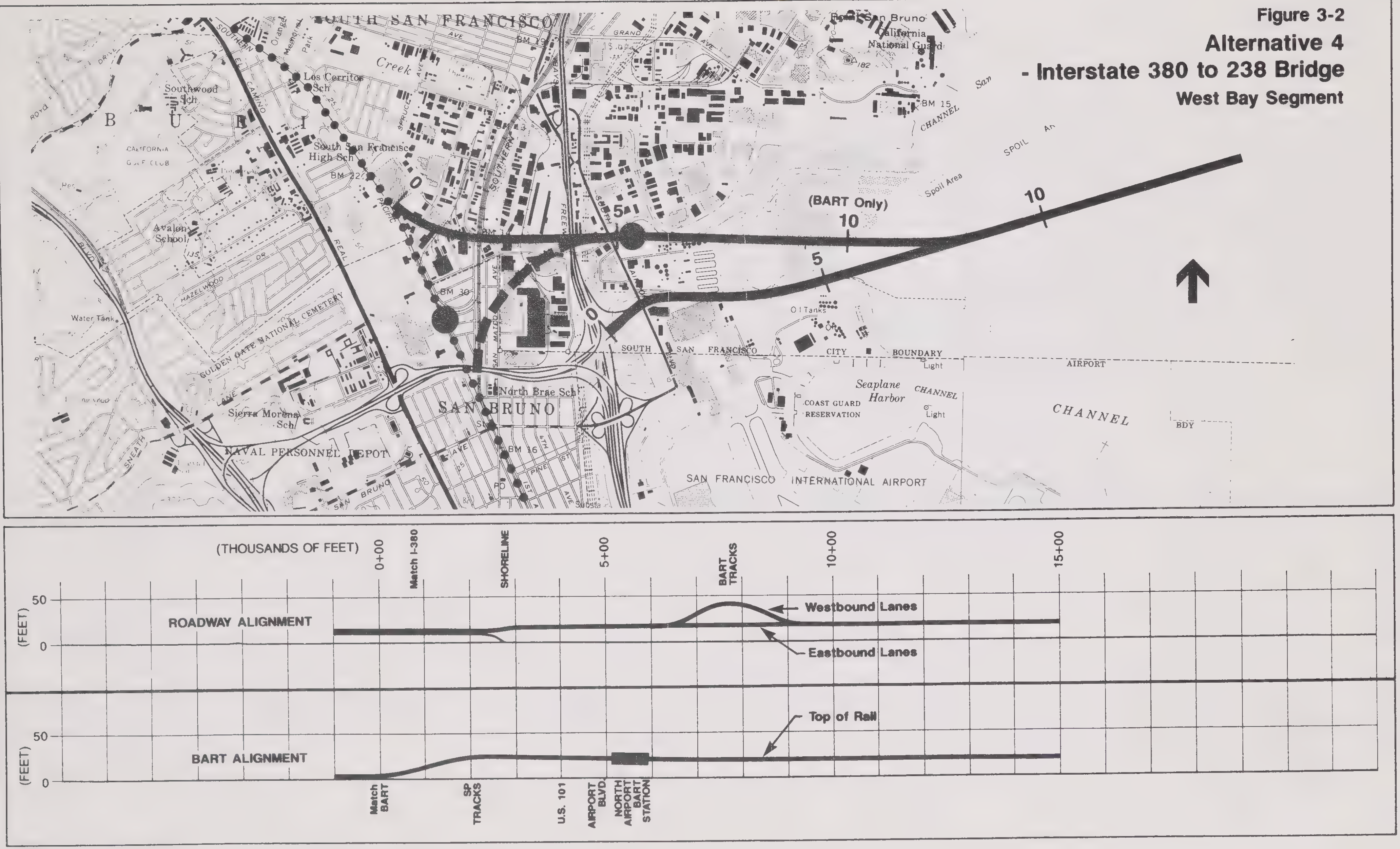
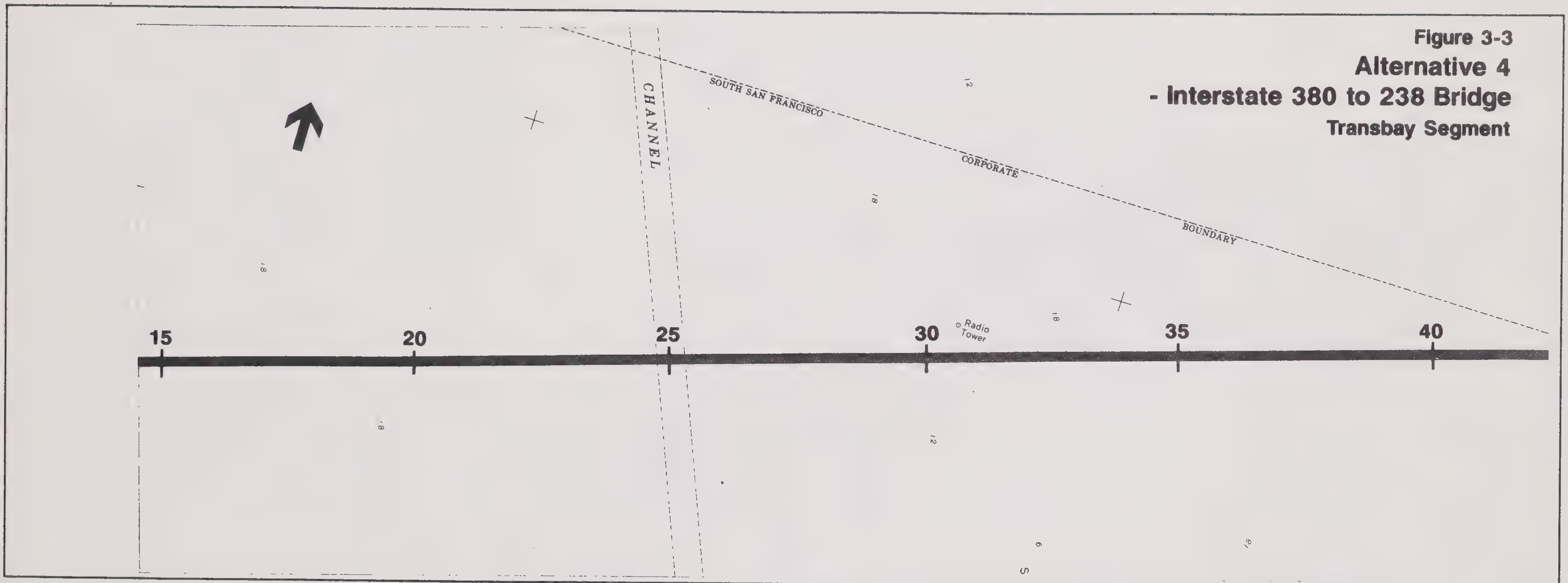


Figure 3-3
Alternative 4
- Interstate 380 to 238 Bridge
Transbay Segment



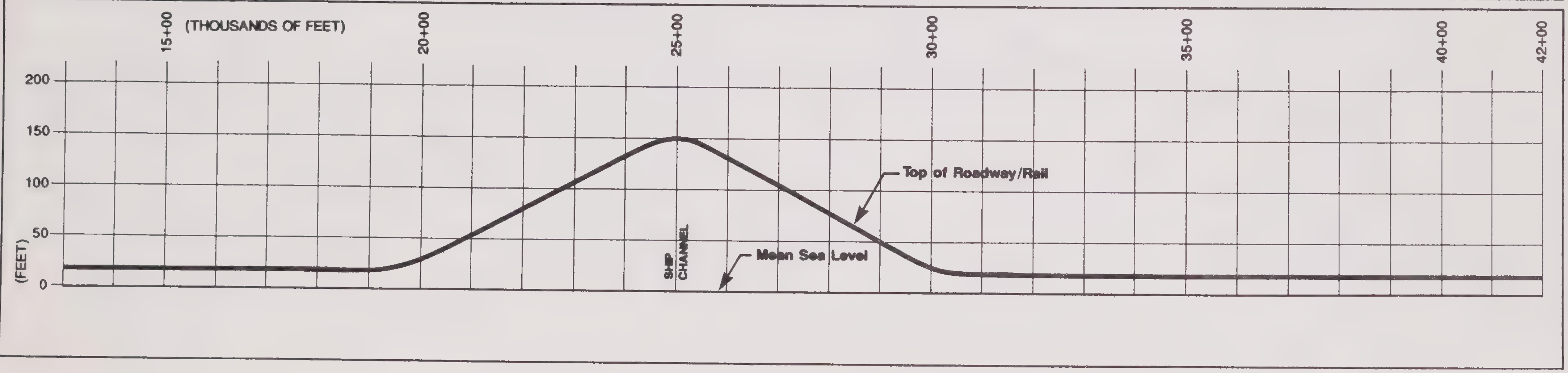
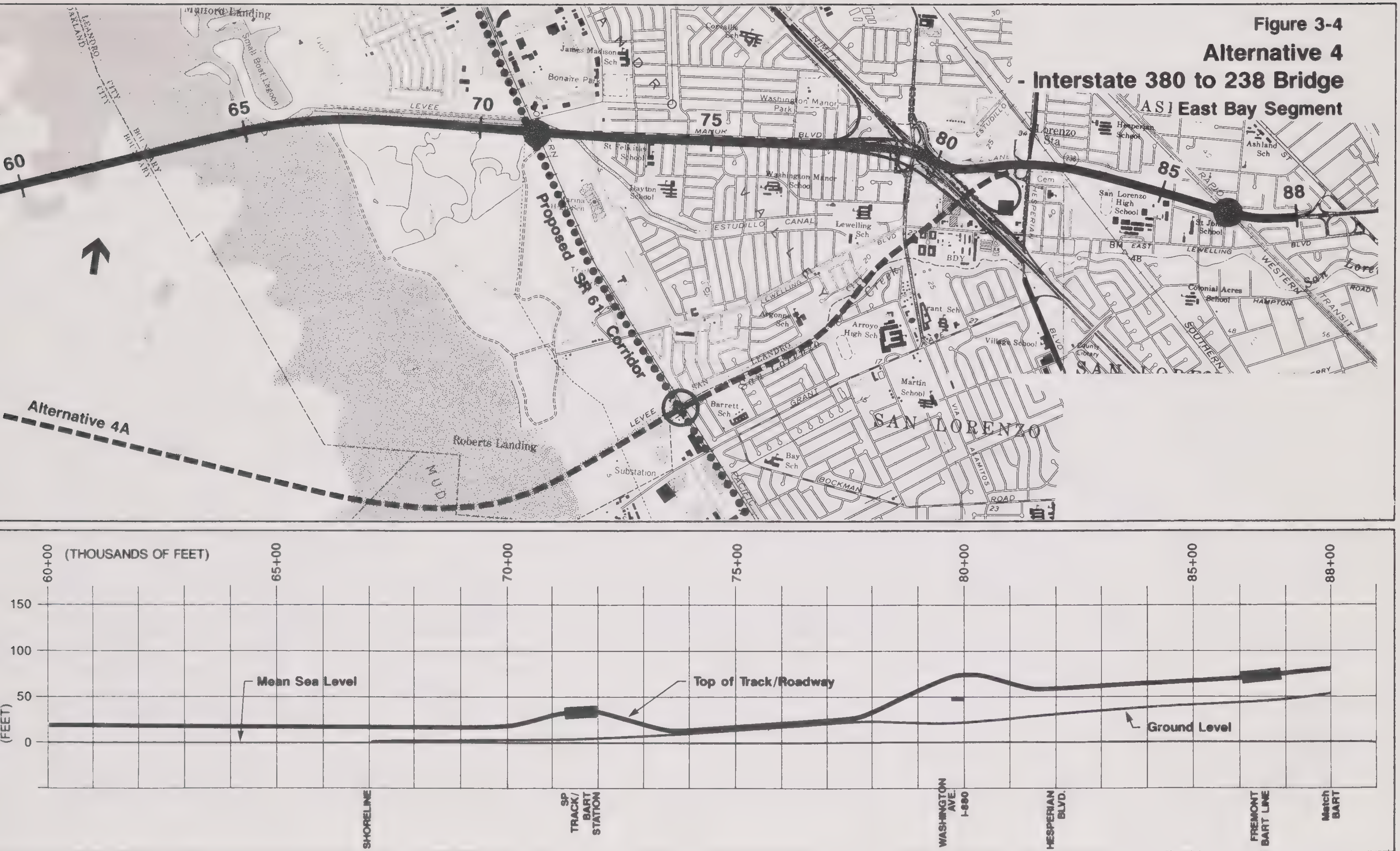


Figure 3-4
Alternative 4
- Interstate 380 to 238 Bridge
East Bay Segment



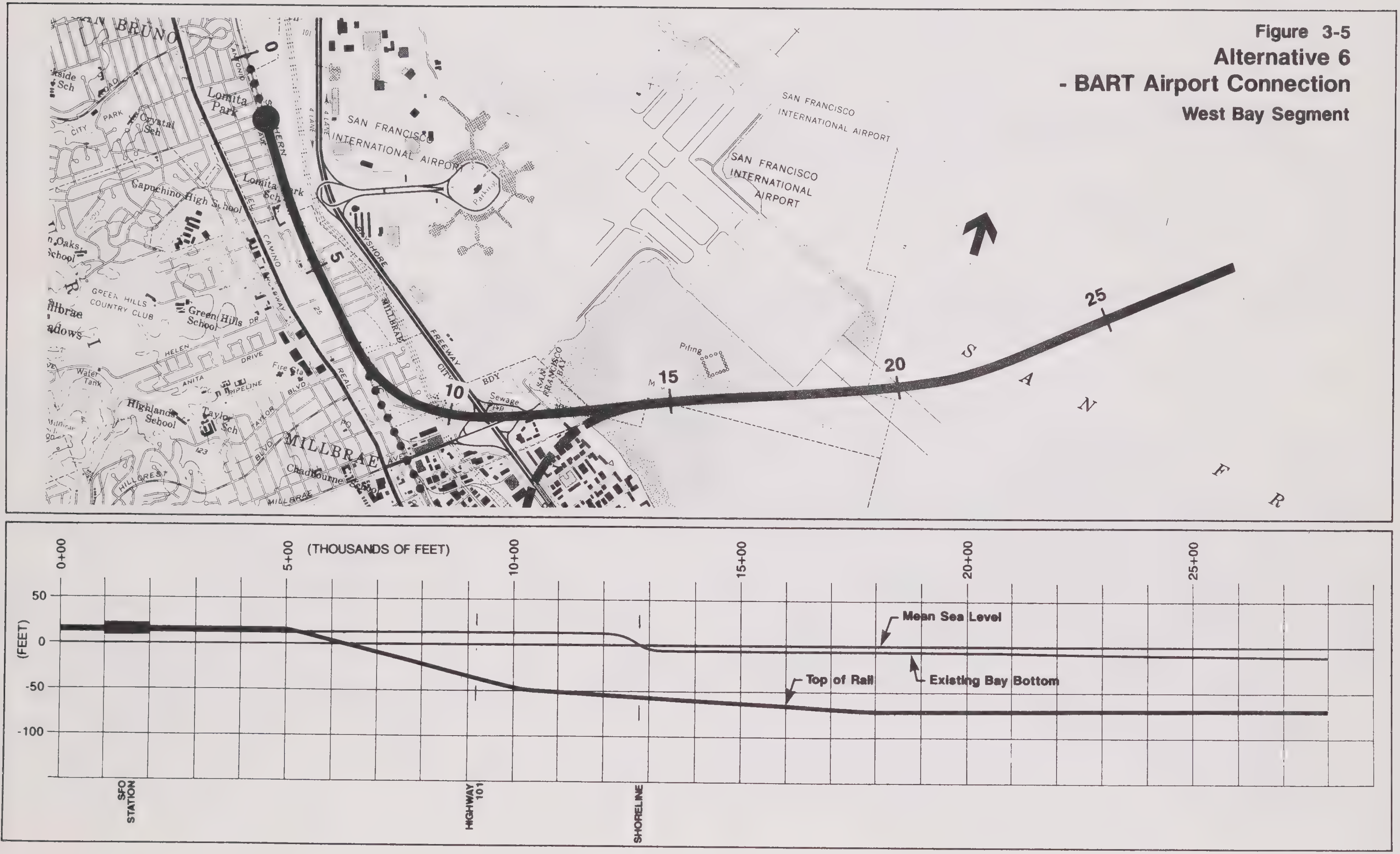


Figure 3-5
Alternative 6
- BART Airport Connection
West Bay Segment

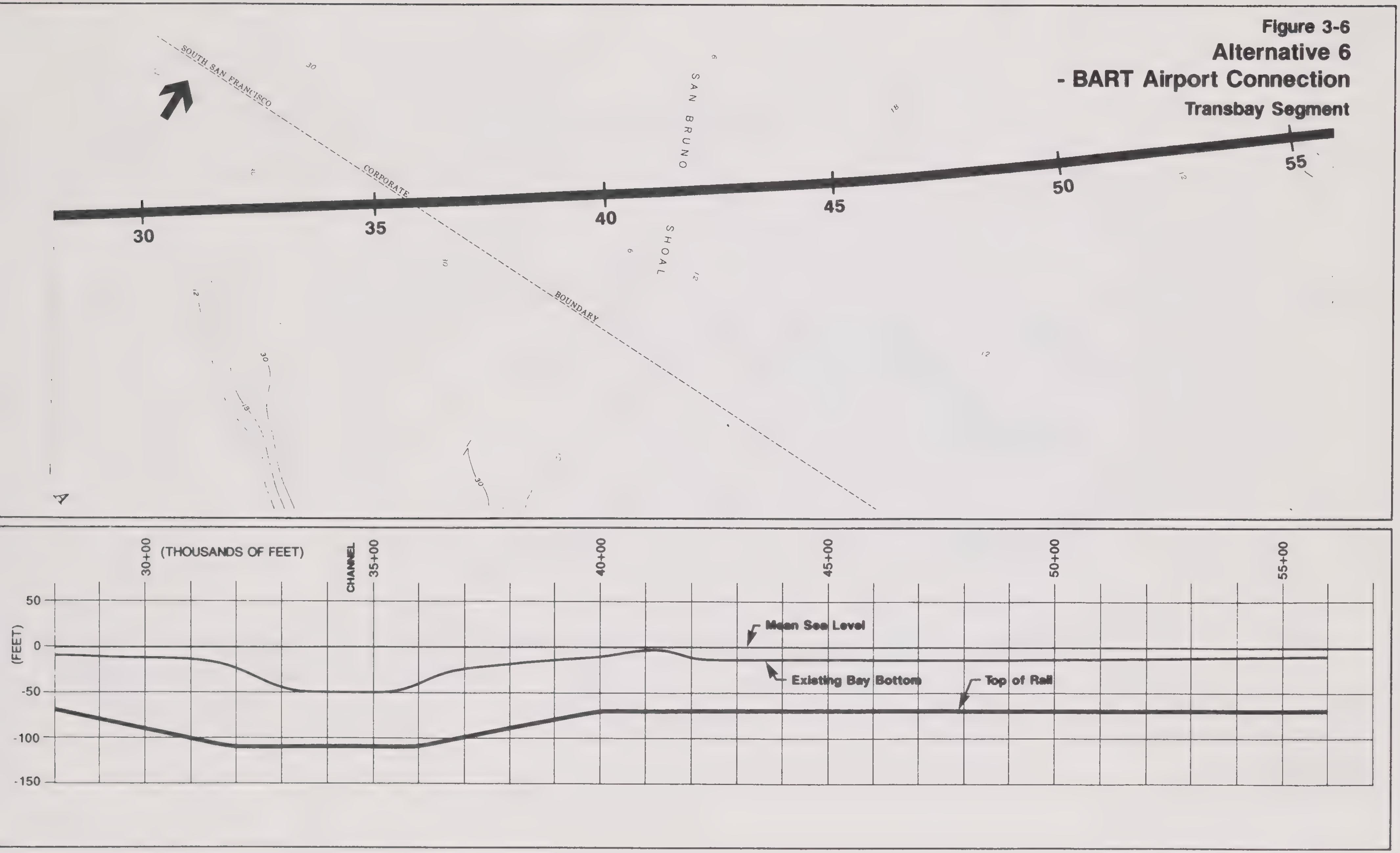


Figure 3-6
Alternative 6
- BART Airport Connection
Transbay Segment
SOUTH SAN FRANCISCO
CORPORATE
BOUNDARY
SAN BRUNO
SHOAL
30
35
40
45
50
55
(THOUSANDS OF FEET)
CHANNEL
30+00
35+00
40+00
45+00
50+00
55+00
(FEET)
50
0
-50
-100
-150
Mean Sea Level
Existing Bay Bottom
Top of Rail

Figure 3-7
Alternative 6
- BART Airport Connection
East Bay Segment A

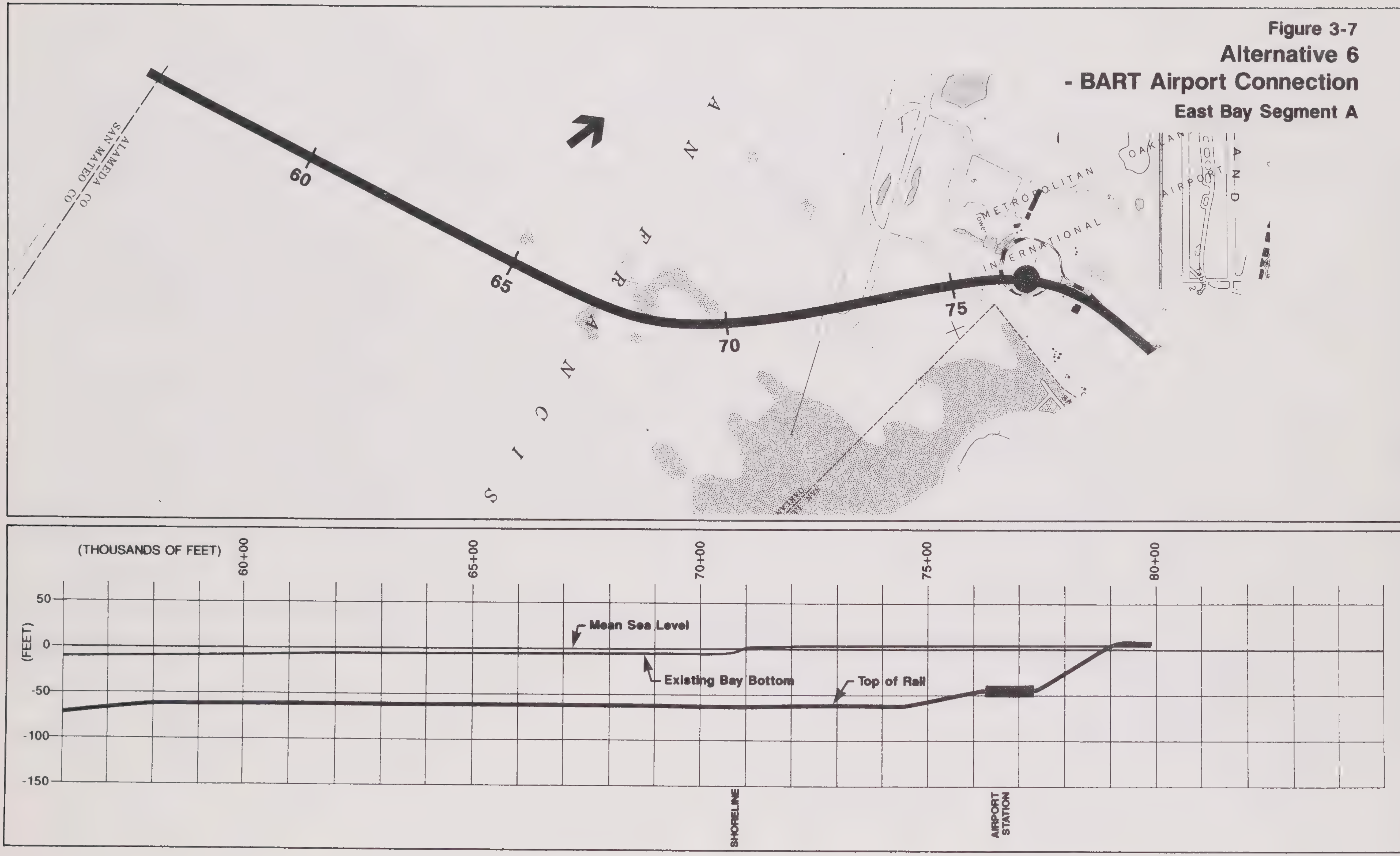
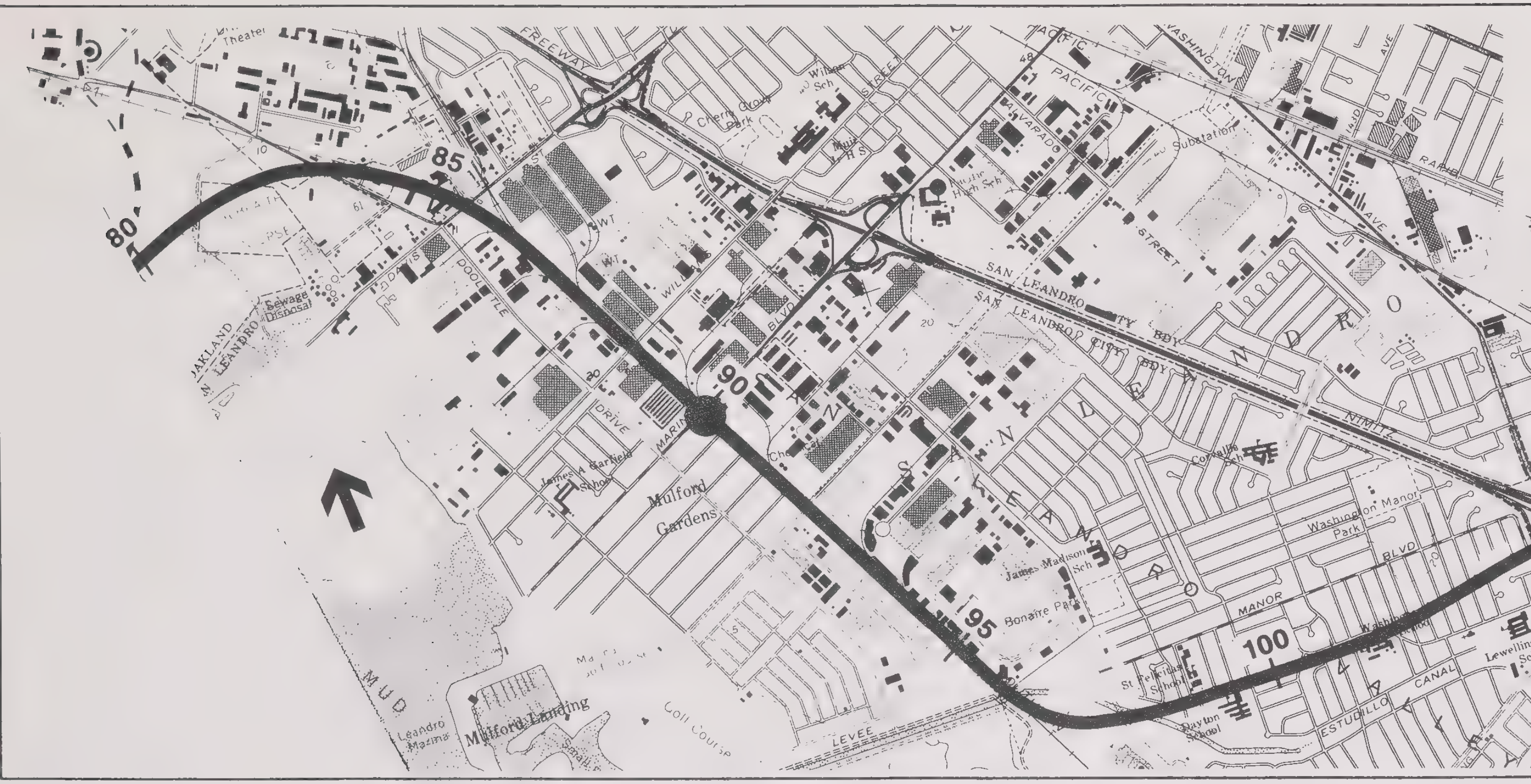


Figure 3-8
Alternative 6
- BART Airport Connection
East Bay Segment B



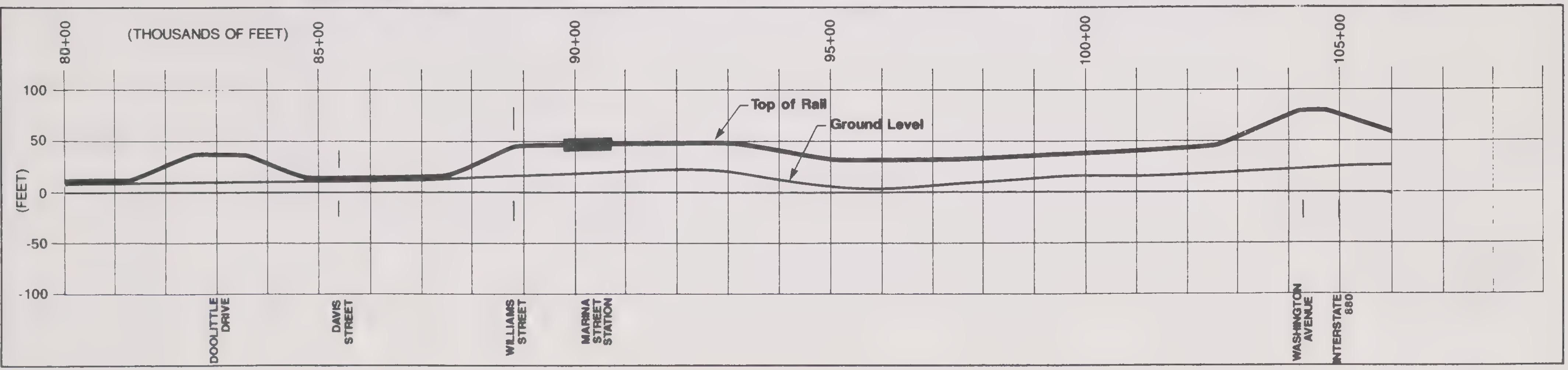


Figure 3-9
Alternative 6
- BART Airport Connection
East Bay Segment C

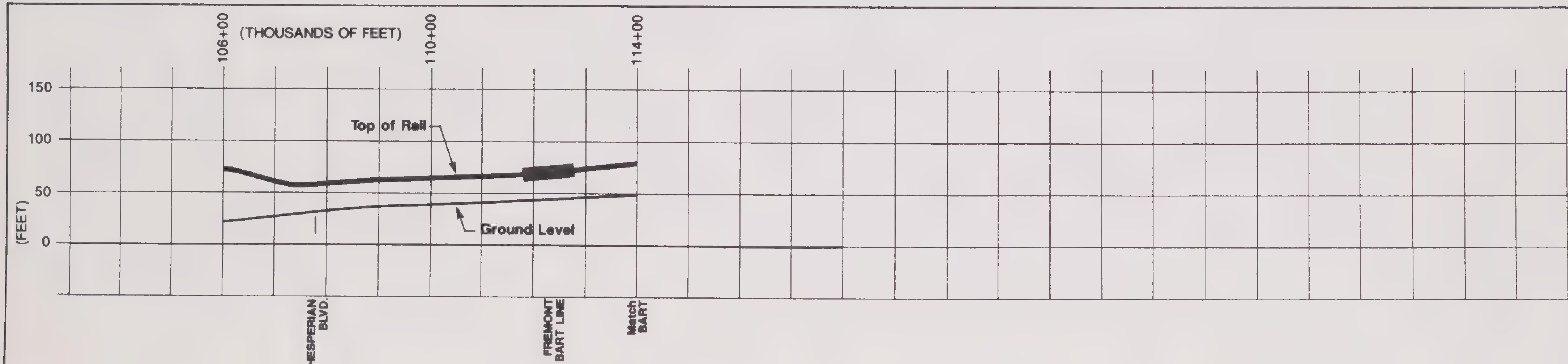


Figure 3-10
Alternative 8
- BART Transbay Tube
West Bay/Transbay Segment

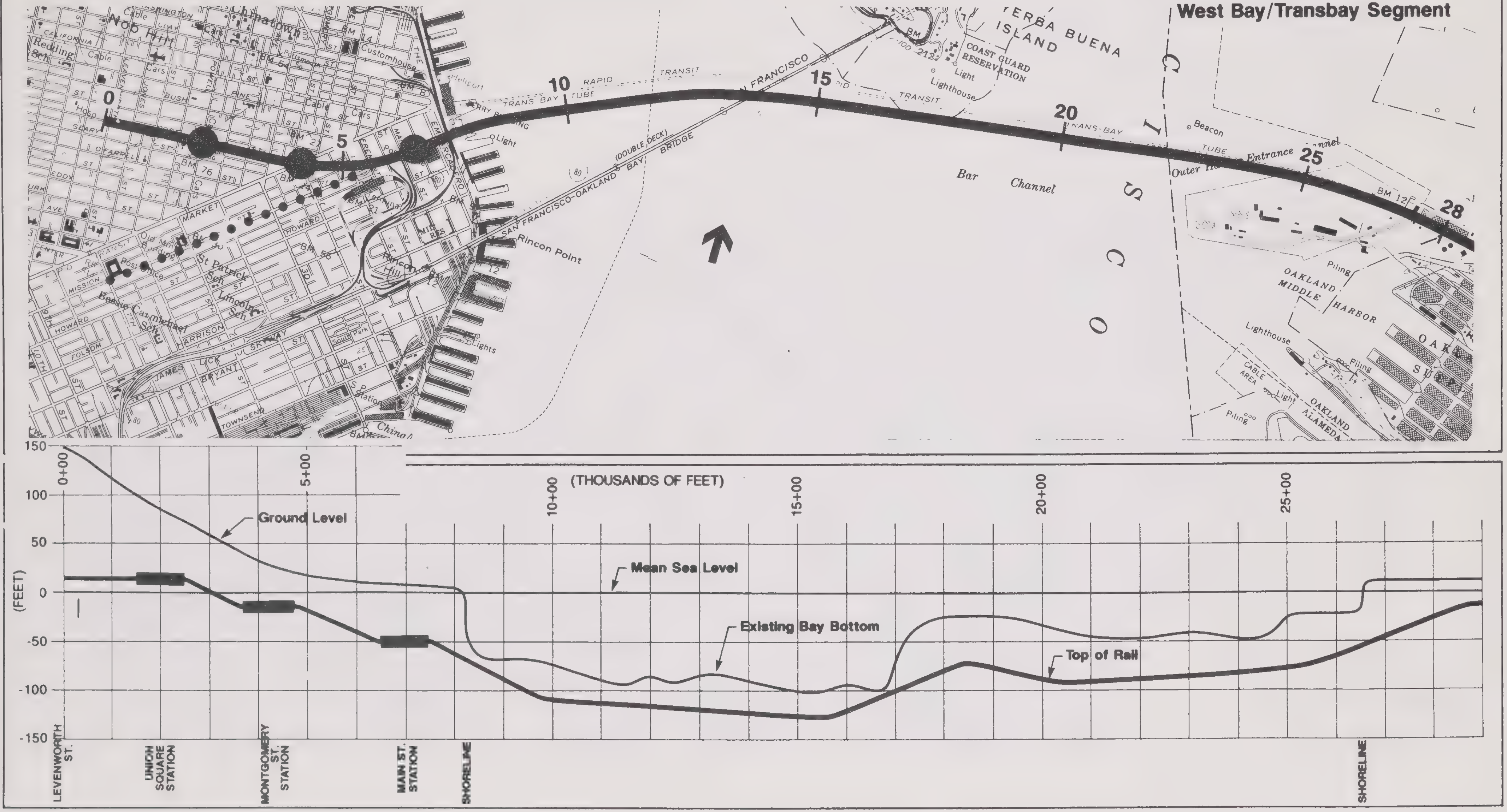


Figure 3-11

Alternative 8
- BART Transbay Tube
East Bay Segment

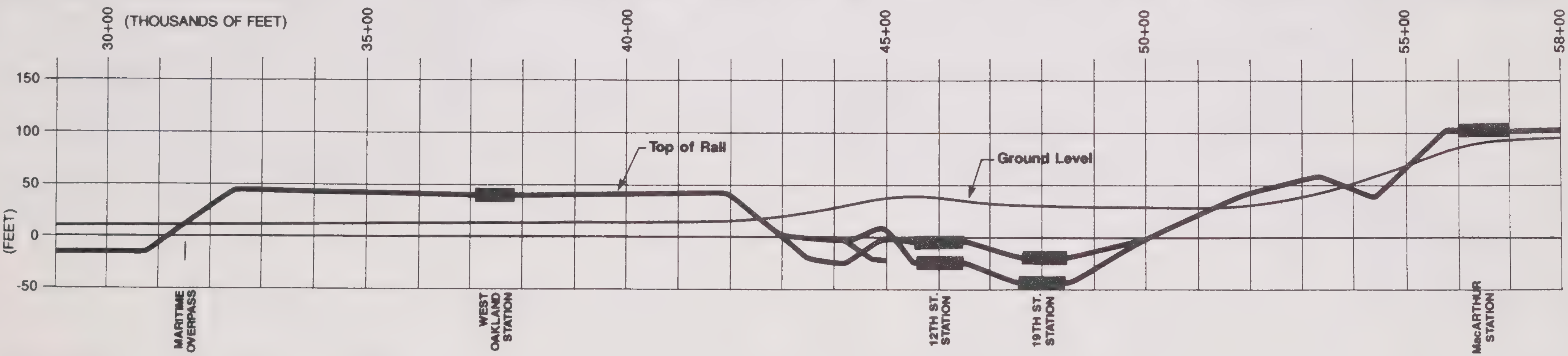


Figure 3-12
Alternative 11
- Inter-City Railroad Tunnel
West Bay/Transbay Segment

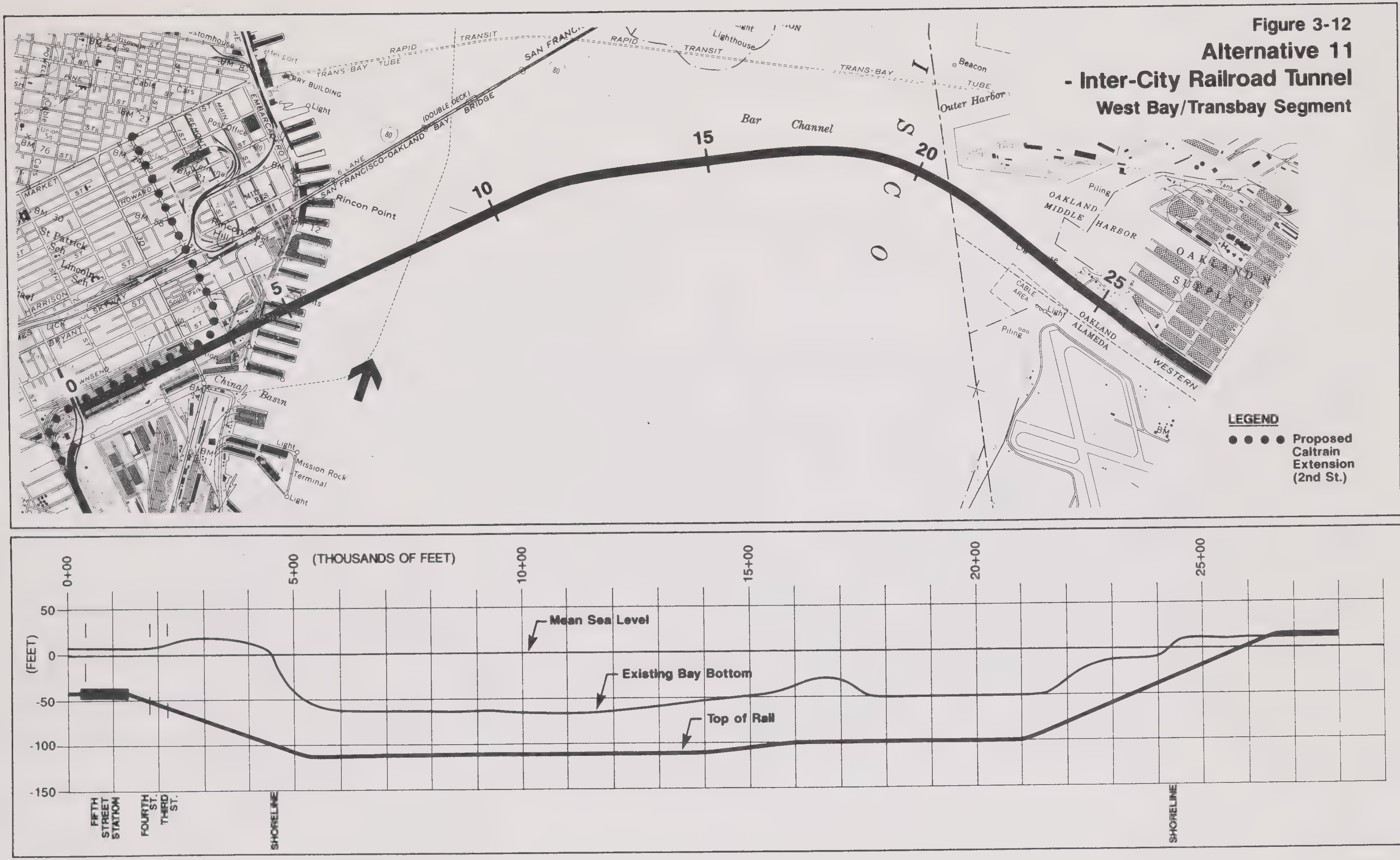
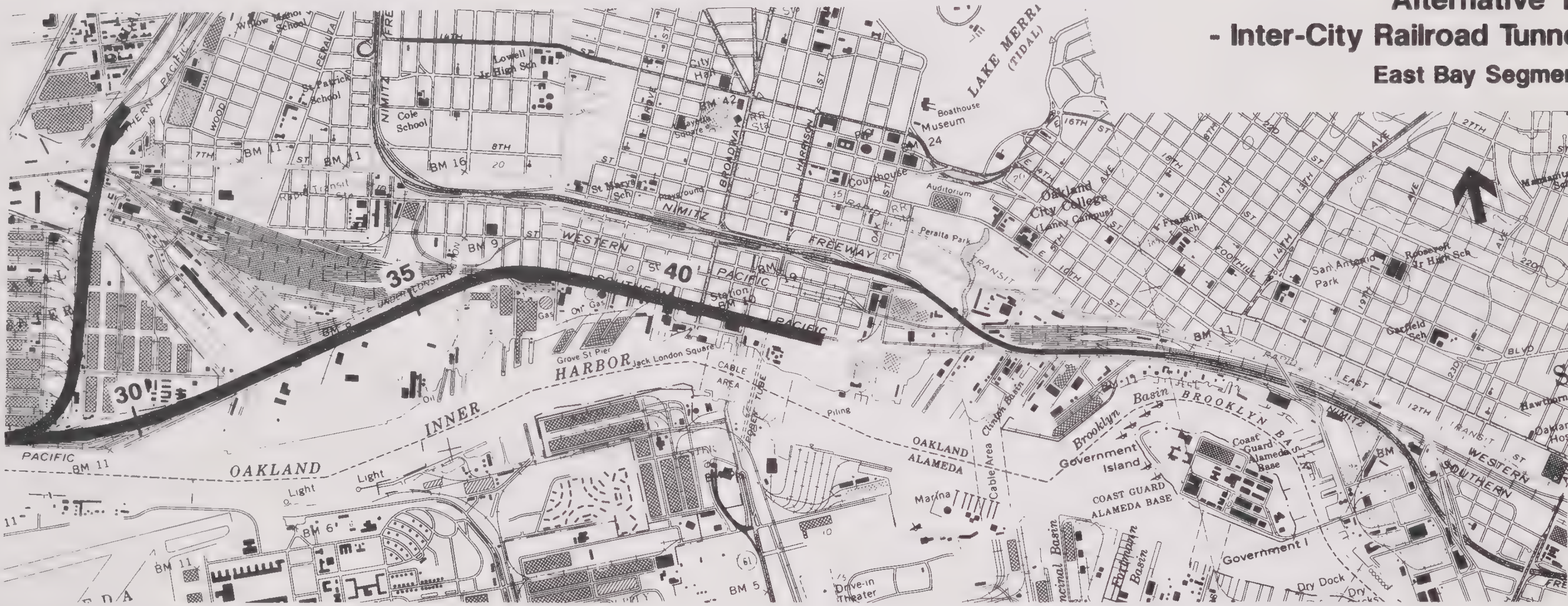
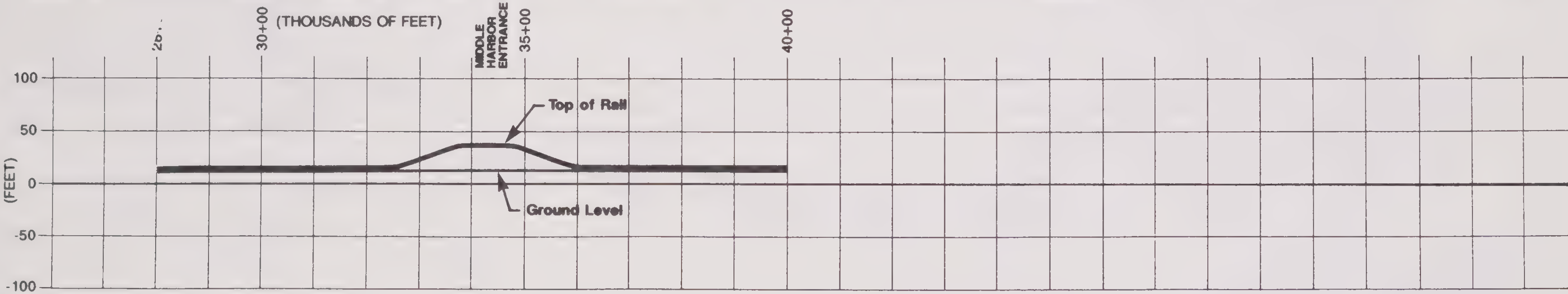


Figure 3-13

Alternative 11 - Inter-City Railroad Tunnel

East Bay Segment





4. TRAVEL REPORT

SECTION 4
TRAVEL REPORT

4.1 INTRODUCTION

This section presents the significant results of the travel performance analysis of the five bay crossing alternatives, including daily and peak period travel forecasts, highway volumes and transit ridership. Comments are made regarding the capacity utilization of the various alternatives studied. The "market area" for the new bridge (Alternative 4/4A) is indicated. Various factors affecting the travel forecast, including land use and toll sensitivity, are addressed.

4.2 KEY FINDINGS

The following key findings are delineated in this section:

- Transbay travel demand (highway plus transit person-trips) will increase by approximately 25 percent by the Year 2010. This demand increase would occur with or without construction of a new bay crossing. Construction of a new bay crossing would not significantly further increase transbay travel demand.

- The base case RTP Blend set of improvements, which includes widening of the San Mateo Bridge to six lanes and more frequent BART transbay service, will provide enough capacity to accommodate the 715,000 daily person-trips crossing the Bay in the study area in the Year 2010.

- The Bay Bridge is at maximum capacity for 1.5 hours today, with heavy congestion over a longer period. With Year 2010 travel demand and no new bridge, the Bay Bridge would be at maximum capacity for 3.5 hours and heavy congestion would extend over an even longer period.

- Peak hour BART load factors on transbay lines exceed policy levels today. Capacity increases due to anticipated reduction in BART headways in the

transbay tube would increase capacity by about 50 percent by the Year 2010, however, at that time, BART would again be approximately at capacity due to projected travel demand increases.

- Of five bay crossing build alternatives studied, a mid-bay bridge in the I-380/I-238 corridor with BART would carry the greatest number of daily trips. Year 2010 travel on such a facility would be similar to the current level of travel accommodated on the Dumbarton Bridge. These trips could be accommodated on the existing bridges and BART, though there would be greater congestion, longer travel times, and a 3.5 hour peak period on the Bay Bridge.

- Although originally defined as an eight-lane facility with BART, travel model results indicate the facility could be constructed with four mixed-flow lanes and provisions for BART. At such time when a future BART connection is warranted, the bridge deck could be expanded to carry BART.

- A new bridge crossing would reduce daily volumes on the Bay Bridge and San Mateo Bridge by 15,000 vehicles and would reduce volumes on the San Mateo Bridge by 6,000 vehicles. Peak hour volumes on the Bay Bridge would not be significantly reduced, however, the duration of the peak period on the Bay Bridge would be shortened by one hour or more. (Without additional bay crossing capacity, the length of peak period on the Bay Bridge is forecast to more than double compared to today's condition.) By providing a "missing link" in the Bay Area highway network, regional highway vehicle miles traveled would be reduced by about 2-million daily.

- In addition to relieving the Bay Bridge, a new bay crossing would serve an emerging mid-bay travel market, which will increase over the next 20 years. For example, the new bridge would cut peak-hour travel times between the Oakland Airport and the San Francisco Airport by 20 minutes.

- US 101 is projected to exceed capacity approaching downtown San Francisco with the RTP Blend scenario. This condition warrants consideration of extending the Peninsula US 101 HOV/auxiliary lane project shown in the Metropolitan Transportation Commission (MTC) Regional Transportation Plan further north (from Millbrae Avenue) into San Francisco. If accomplished, such a system improvement could result in attraction of higher levels of HOV's as well as single-occupant traffic on the new bridge with correspondingly greater levels of relief for the Bay Bridge.

- Of the various transit lines studied, a second BART tunnel across the Bay (Alternative 6) at the same approximate location as a new highway bridge, linking the San Francisco Airport with Oakland Airport, would attract the greatest number of trips. (BART operating on a new highway bridge would attract 80 percent of the trips as a "BART-only" tube.)

- Ferry system enhancements (Alternative 1) consisting of additional routes with faster vessels operating on frequent headways could result in ferry ridership many times today's levels. Of the routes studied, highest ridership was obtained in the congested I-80 highway corridor north of the Bay Bridge. This service would relieve the Bay Bridge.

- A sensitivity analysis conducted for this study showed that a four-dollar toll increase applied to all bridge crossings in the study area would reduce transbay vehicular demand by as much as 13 percent. However, transit demand would increase by 10 percent, therefore pushing BART load factors further above capacity.

- An "infill" alternative land use scenario was run by MTC for the RTP. The result of this test indicated that transit ridership would increase by about 12 percent regionwide, highway volumes would also increase about 4 percent regionwide, and transbay travel would increase by an additional 6 percent. This land use would therefore further strain the capacity of the BART transbay tube and existing highway crossings.

- While Year 2010 demand can be met by pushing the highway and BART systems to capacity for trips to San Francisco, continued growth in employment in that city beyond that year would exceed existing bay crossing capacity.

- Given that capacity in the BART tube and Bay Bridge would be a critical issue in the Year 2010, a land use assessment and transportation forecast capability must be developed to plan adequately for the Year 2010 - 2030 era when substantial capacity increases for transbay travel may be necessary.

4.3 BAY CROSSING TRAVEL FORECAST RESULTS

For the purpose of this study, the fundamental measure of travel performance is the number of future daily trips carried in each travel scenario. Daily trips provides a general indication of the loading of transportation facilities and directly relates to the revenues generated by tolls and fares.

Year 2010 travel has been measured in daily person-trips for both highway and transit facilities, to provide a common basis for comparison of the two modes. In addition, the total daily vehicular volume has been identified for roadways, since this latter figure provides a better indication of the loading on highway facilities.

The daily travel analysis includes consideration both for the amount of trips which would be carried on new or enhanced transportation facilities included in each alternative, as well as an evaluation of the total transbay travel carried in the study area.[1]

---

[1] Defined as from the San Francisco-Oakland Bay Bridge to the Dumbarton Bridge for the highway/rail network and from the San Francisco and Peninsula area to the East and North Bay counties, for the ferry system.

Total Daily Transbay Travel

Figure 4-1 indicates a comparison of existing and future study area person-trips carried by travel mode. (Existing trips are based upon 1989 pre-earthquake data.[1])

There will be a substantial (23 percent) increase in daily transbay travel by the Year 2010, even without construction of new bay crossings.

There would be insignificant differences in total travel between the RTP Blend and "transit-only" bay crossing Alternatives 1, 6, 8, and 11.

Alternative 4, which would provide a new bridge with BART, would result in slightly higher transbay auto volumes relative to the RTP Blend, due to the fact that some trips which would remain on roadways on either side of the Bay, or travel around the Bay, would be attracted to destinations across the Bay with a new bridge in place. With this alternative, transbay travel would be about 3.5 percent higher than with the RTP Blend network.

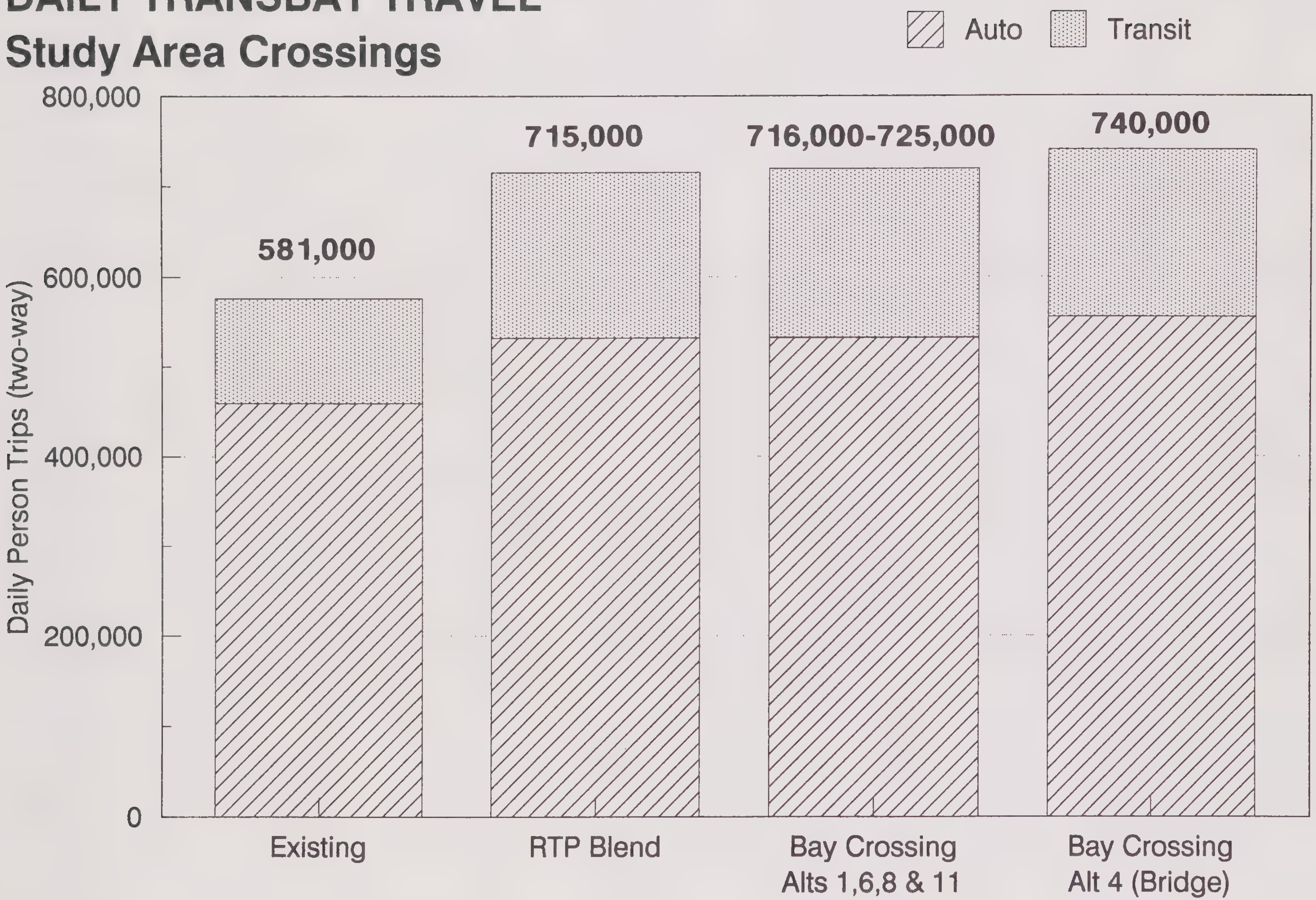
Table 4-1 provides a breakdown of daily trips by bay crossing facility. Alternatives 4 and 6 are indicated. Vehicular trips for Alternatives 1, 8, and 11 would be similar to Alternative 6; the transit ridership for these alternatives is detailed further in this section.

---

[1] Since the earthquake, BART has attracted and retained some 18,000 daily transbay riders, but the Bay Bridge volume has climbed back to the pre-earthquake level, indicating that the increased BART patronage may have come from decreases in ridesharing.

Figure 4-1

DAILY TRANSBAY TRAVEL
Study Area Crossings



Korve Engineering, Inc.

TABLE 4-1
TRANSBAY TRAVEL BREAKDOWN BY FACILITY
Year 2010 Daily Person Trips

Facility	Alternative 4 (New Bridge with BART)	Alternative 6 (Airport to Airport BART Tube)
Bay Bridge	334,000	354,000
New Bridge	53,000	n/a
San Mateo Bridge	90,000	97,500
Dumbarton Bridge	78,000	80,500
ST: HIGHWAY PERSON-TRIPS	555,000	532,000
Existing Transbay BART Tube	153,000	158,000
New BART Crossing	13,000	16,000
Bus	16,000	16,000
Ferry	3,500	3,500
ST: TRANSIT PERSON-TRIPS	185,500	193,500
GRAND TOTAL	**740,500**	**725,500**

Daily Trips Carried by Alternative

Figure 4-2 provides a comparison of future daily person-trips carried by mode on new bay crossing facilities defined by the study alternatives. The bars indicate the approximate number of Year 2010 daily trips carried relative to the study baseline which was the RTP Blend.

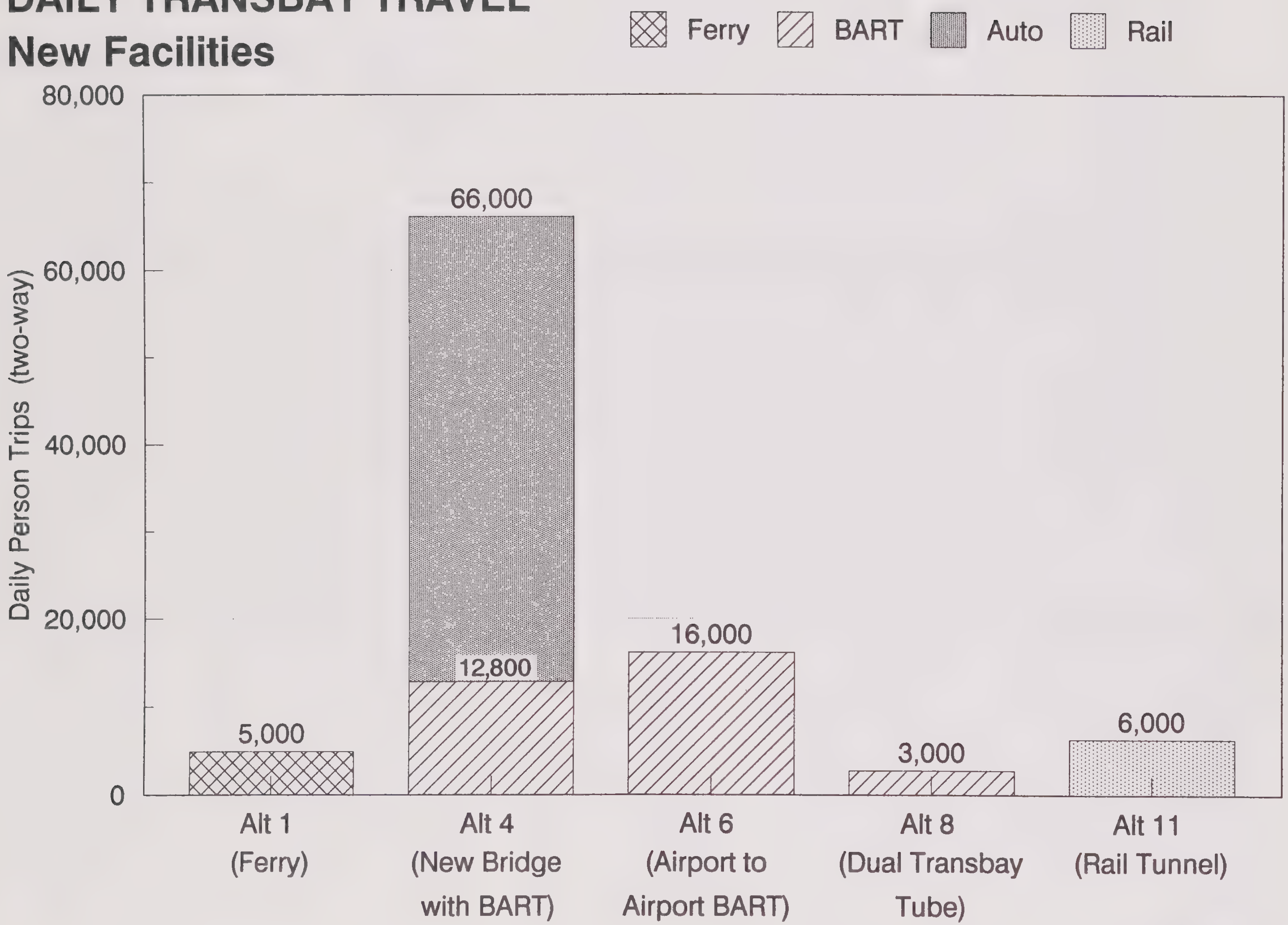
The following points should be noted for each alternative.

Alternative 1: RTP Blend + Ferry

An enhanced ferry system would show an increase in ridership approaching 5,000 daily passengers relative to the RTP Blend. This gain in ridership exceeds the total ridership projected with the RTP Blend of some 3,600 persons, indicating the effectiveness of enhanced ferry services to attract higher ridership levels than current services. In view of the fact that the MTC

Figure 4-2

DAILY TRANSBAY TRAVEL
New Facilities



Korve Engineering, Inc.

model has not been specifically calibrated to forecast ferry patronage, it is possible that higher levels of ridership could be projected.

Alternative 4: RTP Blend + New Bridge with BART

The greatest number of trips would be carried with Alternative 4, which would provide both a highway and a BART connection. The amount of person-trips carried is comparable to the amount of travel which occurs over the Dumbarton Bridge under existing conditions, and represents about 10 percent of all transbay travel. Alternative 4 was relatively high in terms of projected BART patrons compared to the other alternatives, reflecting new transit coverage and route opportunities provided by the new bridge.

The number of trips forecast for the new bridge is significantly less than the eight-lane capacity included in the definition of the alternative and which was used for the cost analysis. Since the projected demand corresponds to a four-lane facility, we recommend that the bridge alternative be scaled back to a four-lane highway bridge with provisions for adding BART.

Alternative 6: RTP Blend + Airport-Airport BART

This alternative was the most attractive of the BART alternatives studied, due to the fact that significant new system coverage would be provided compared to other alternatives. This alternative was more attractive than Alternative 4, from a transit perspective.

Alternative 8: RTP Blend + Dual Transbay Tube

This alternative was the least attractive of all of the transit alternatives studied in terms of BART trips carried over the RTP Blend scenario. (Note that the result shown in Figure 4-1 is strictly the increase in trips over the RTP Blend -- in reality, substantial amounts of riders would be served by a second transbay tube through diversion of trains and riders from the existing transbay tube.)

Alternative 11: RTP Blend + Rail Tunnel

The rail tunnel alternative would carry a moderate amount of daily riders relative to the other transit alternatives studied. While a rail tunnel would add transit coverage, heavy rail headways

would not be as frequent as those provided by BART service. In addition to passengers, this alternative could also accommodate freight service. The MTC travel model does not provide point-to-point estimates of goods movements and special studies would be necessary to accurately define the potential demand for freight services.

Effect of New Bridge on Transbay Vehicle Volumes

Daily Traffic Levels

Alternative 4 would provide a new highway connection between I-238 in southern San Leandro and I-380 immediately north of San Francisco International Airport. Figure 4-3 shows daily bridge volumes on study area bridges in the baseline RTP Blend scenario (with existing bridges) and in Alternative 4 (with new bridge).

With the new bridge, daily volumes on the Bay Bridge would decline by about 13,000 trips, daily volumes on the Hayward-San Mateo bridge would decline by 18,000 trips, and volumes on the Dumbarton Bridge would decline by about 1,000 trips.

The travel model results indicate slightly higher total daily bridge volumes (up 4.5 percent) with Alternative 4 relative to the RTP Blend, reflecting shifts in travel distribution due to a significant new highway facility.

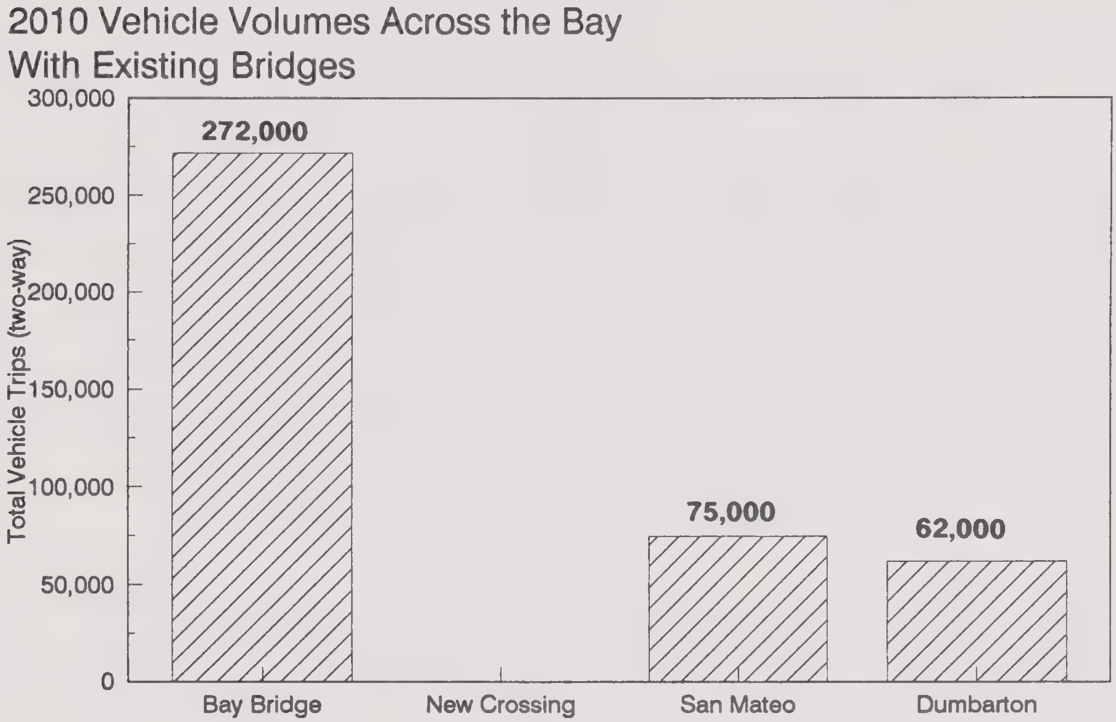
Peak Period Conditions

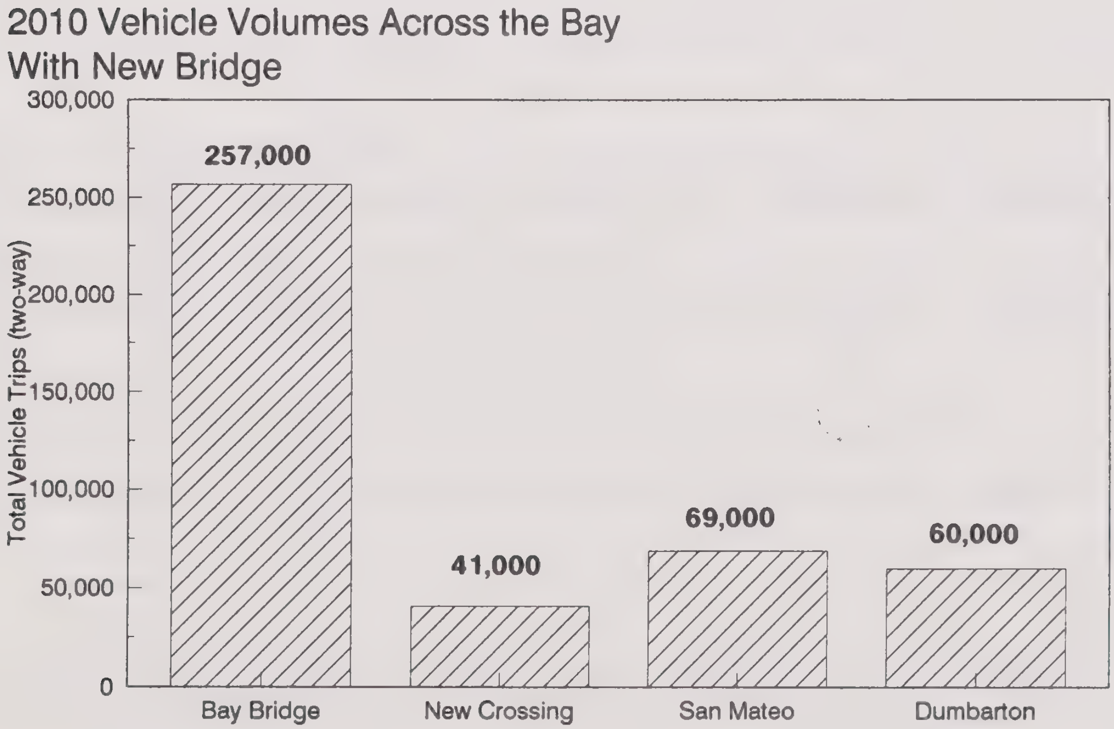
A principal measure of peak period highway congestion is the Volume/Capacity (V/C) ratio, which represents the utilization of capacity. Table 4-2 shows projections for bridges in the study area. With the RTP blend, the Bay Bridge westbound A.M. V/C would be 1.17, indicating that travel demand would be 117 percent of capacity. Other bridge V/Cs would be below capacity. (Note that the San Mateo Bridge would be widened to six lanes in the RTP Blend, eliminating an over-capacity condition which would otherwise occur on that facility as well.)

Figure 4-3

DAILY TRAFFIC VOLUMES ON BRIDGES

Without and With New Crossing





Korve Engineering, Inc.

TABLE 4-2
AM PEAK HOUR VOLUMES AND VOLUME/CAPACITY RATIOS
RTP Blend and Alternative 4

Bridge	Direction	RTP Blend Volume	RTP Blend Volume/Capacity	Alternative 4 Volume	Alternative 4 Volume/Capacity
San Francisco Bay Bridge	WB EB	11,700 7,300	1.17 0.73	11,000 7,000	1.10 0.70
I-380/I-238 (new bridge)	WB EB	N/A	N/A	2,200 1,200	0.28 0.15
San Mateo-Hayward	WB EB	4,800 2,400	0.80 0.40	4,400 2,200	0.73 0.37
Dumbarton	WB EB	3,600 1,200	0.60 0.20	3,500 1,200	0.58 0.20

With Alternative 4, peak hour V/C ratios would decline. In the A.M. in the more heavily traveled westbound direction, V/Cs on the Bay Bridge and Hayward Bridge would be improved by about .07, representing 7 percent of the respective capacity of each facility. A smaller level of relief would be provided to the Dumbarton Bridge. Although peak hour congestion at the Bay Bridge would decline, the travel demand would remain above capacity during the peak hour.

The V/C of 0.28 computed for the new bridge in the peak westbound A.M. condition was based upon the definition of Alternative 4, which was for an eight-lane facility. The projected travel demand, however, corresponds to a four-lane facility. If a four-lane bridge were constructed, the resulting westbound A.M. peak hour V/C ratio would be 0.55, which would result in acceptable operating speeds on the new bridge.

While it is unlikely that construction of the new bridge could significantly reduce the traffic flow level of the Bay Bridge during the heart of the peak hour, a new bridge would significantly lessen the duration of the peak period at the Bay Bridge.

Figure 4-4 illustrates the potential impact of the new bridge in reducing the peak period. The Bay Bridge typically operates "at capacity" for about 1.5 hours (6:30 - 8:00 A.M.), based upon recent count data.[1] Without a new bridge (indicated by the RTP blend volumes shown in Figure 4-3), the at-capacity condition would more than double to 3.5 hours (5:45 - 9:15 A.M.).

The reduction in daily volume on the Bay Bridge due to construction of the new bridge would be concentrated in the A.M. and P.M. peak periods, when significant amounts of diversion away from the Bay Bridge could occur. With construction of a new bridge, the peak flow period would be reduced by one hour, resulting in a 2.5 hour peak period in the Year 2010 (6:15 - 8:45 A.M.).

This analysis is strictly based upon the travel model peak hour assignment. Given the resulting length of peak hour projected by the travel model for the Year 2010, it is possible that additional diversion to the new bridge could occur, potentially reducing the length of the absolute peak to today's 1.5 hour timeframe.

Detailed studies of peak hour flow profiles with each of the "transit only" alternatives were not conducted. Based upon the person-trips carried by the transit alternatives, it could be inferred that similar but substantially lesser improvements in peak hour Bay Bridge conditions would result.

Highway Travel Times

Table 4-3 indicates the impact of the new bridge on highway times between selected origins and destinations relative to the RTP Blend. Travel times are computed for the A.M. peak hour based upon the estimated speed on each roadway segment and distance traveled. The table indicates that the new bridge would be highly competitive with the Bay Bridge for San Francisco or northern San Mateo County bound trips originating from southern Alameda County. A 20-minute reduction in travel between San Francisco and Oakland Airports would result.

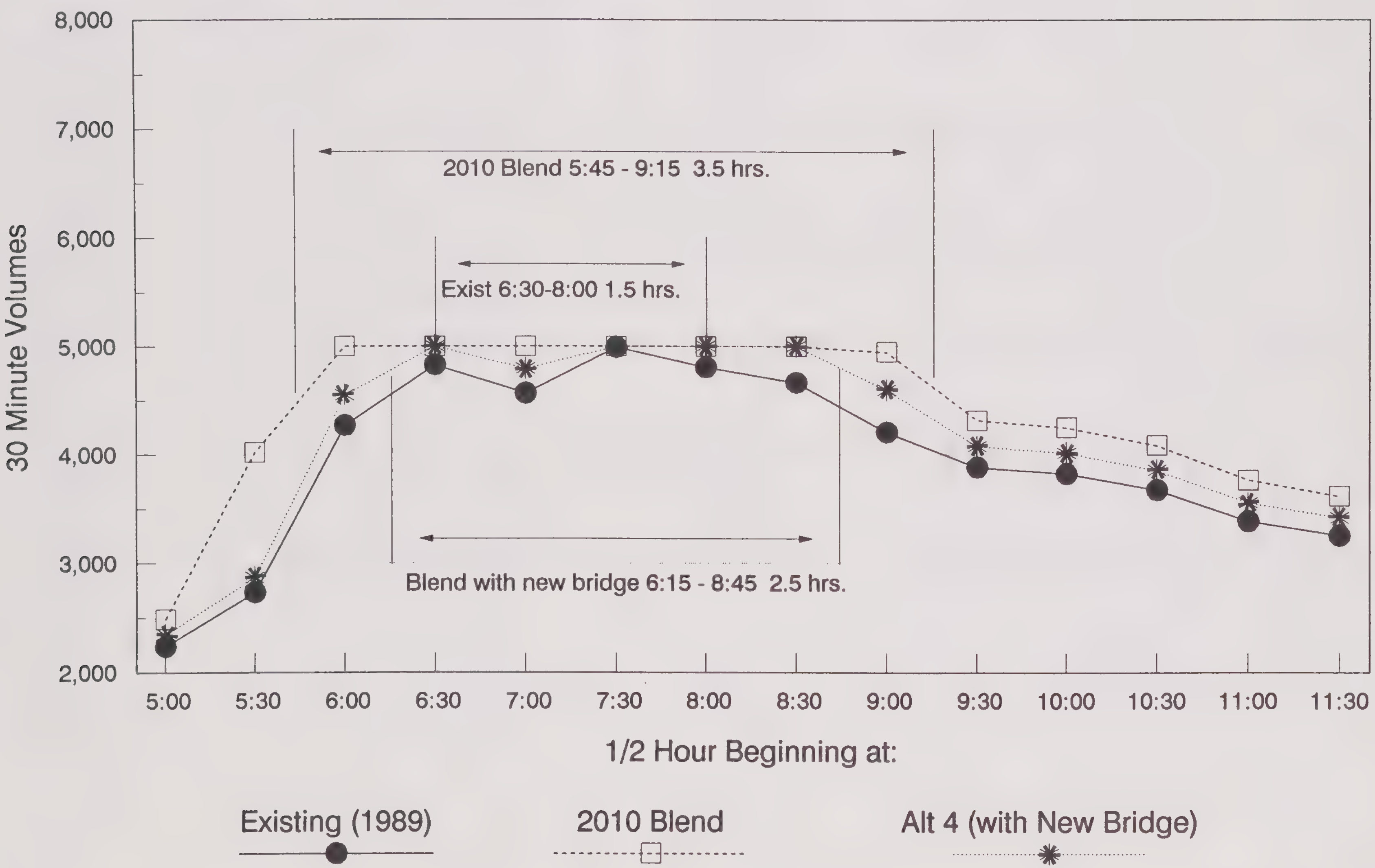
---

[1] This time period corresponds to attainment of the absolute maximum flow level on the bridge. The period of significant toll plaza congestion has a longer duration and lags the period of peak bridge counts due to the time it takes for the queue to build and dissipate.

Figure 4-4

DURATION OF BAY BRIDGE PEAK PERIOD

Westbound AM Traffic Volumes



Korve Engineering, Inc.

TABLE 4-3
AM PEAK HOUR TRAVEL TIME COMPARISON
Minutes Between Selected Origins and Destinations

Origin-Destination	RTP Blend	Alternative 4	
	Via Bay Bridge	Via Bay Bridge	Via New Bridge
Concord - San Francisco CBD	72	70	-
Livermore - San Francisco CBD	116	118	113
Richmond - San Francisco CBD	41	40	-
Fremont - San Francisco CBD	64	62	64
Oakland Airport - SF Airport[1]	58	-	38
Millbrae - Oakland CBD	49	49	49

[1]Blend Alternative time computed via San Mateo Bridge

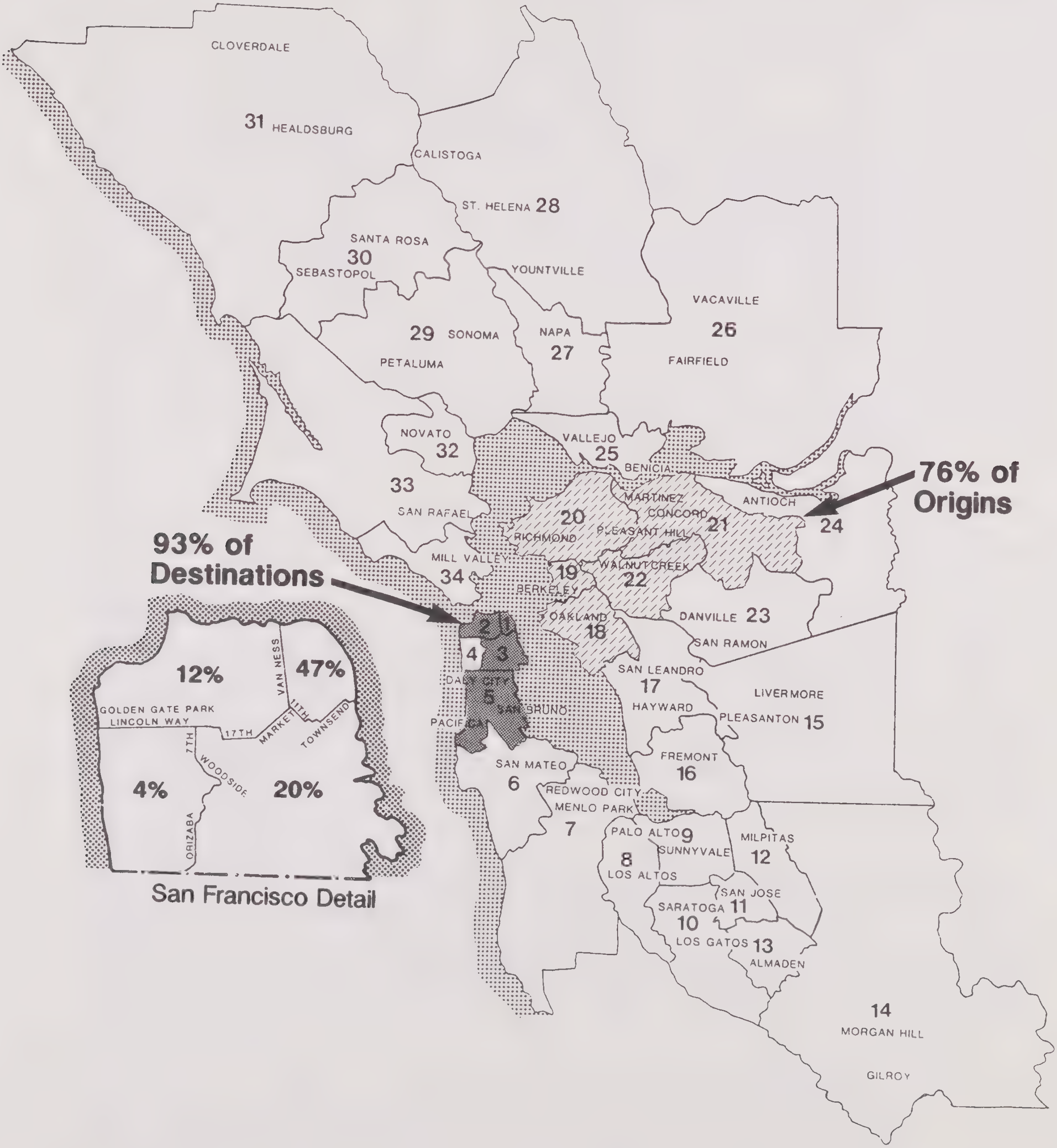
Market Analysis of New Bay Crossing

In order to understand and validate the assumptions incorporated into the travel model demand projection for the new bridge, a comparative analysis of the prime travel market area was performed. Tools in the MTC modeling process allow for determination of the origins and destinations of vehicles passing over a particular facility in the network. An evaluation was made of such travel patterns for both the Bay Bridge and the new crossing contained in Alternative 4. The results are shown in Figures 4-5 and 4-6.

Figure 4-5 indicates that, for the scenario with the new crossing, the Bay Bridge would draw most of its users from the Richmond, Berkeley, Oakland, and Walnut Creek areas. The predominant destination of Bay Bridge users will be San Francisco and northern San Mateo County (93 percent of destinations), with 47 percent ending their trip in downtown San Francisco.

Figure 4-5

PRIME MARKET AREA
Bay Bridge with New Bridge



San Francisco Detail

Korve Engineering, Inc.

Figure 4-6

PRIME MARKET AREA
New Bridge

San Francisco Detail

Korve Engineering, Inc.

Figure 4-6, on the other hand, shows that the new bridge draws most of its users from areas further to the south: East Oakland, San Leandro, San Lorenzo, Hayward, and Fremont would generate 64 percent of trip origins and 79 percent of trip destinations would be to points south of downtown San Francisco.

Further analysis of the model assumptions revealed that the portion of US 101 between the I-280 junction and the Bay Bridge will be significantly overloaded in the Year 2010. Portions of this segment are projected to be as much as 30 percent over capacity, with portions of the parallel segment of I-280 entering central San Francisco also somewhat over capacity. This condition would lower speeds and result in delays to trips made during the peak hour into downtown San Francisco using the new bridge. Capacity improvements along US 101, such as extension of the RTP Blend HOV/auxiliary lane project north from Millbrae Avenue into downtown San Francisco, could significantly enhance the utility of an I-380/I-238 bridge for relieving the Bay Bridge.[1]

Transit Patronage

Table 4-4 provides a detailed breakdown of daily transit trips. Existing volumes are 1989 "pre-earthquake" volumes and are provided for reference. (BART transbay patronage exceeded 226,000 daily trips during the Bay Bridge closure and has since stabilized in excess of 120,000 riders. The existing Bay Bridge daily bus ridership is from data collected by AC Transit after the earthquake.) All other figures are projections for the Year 2010 from the MTC model. (Note that the projected BART "new crossing" demand in Alternative 8 represents the increment of growth over the MTC Blend quantity -- the specific ridership in a second tube would depend upon the operating plan.)

<u>BART and Rail Service</u>

Based upon current BART peaking and directional travel demand patterns, the effective daily capacity of the transbay tube is approximately 100,000 daily seated passengers. Standees add to this capacity, however, BART policy calls for limiting total riders to 1.15 times the number of seated passengers "where possible" in the peak period. (This ratio is called the "load factor".)

---

[1]Northbound US 101 north of Army Street in San Francisco is forecast at 125 percent of capacity with the RTP Blend; this would elevate slightly to 128 percent of capacity with the new bridge.

TABLE 4-4
TRANSBAY TRANSIT PATRONAGE
Total Daily Trips

	Existing	RTP Blend	Alt 1 RTP Blend + Ferry	Alt 4 RTP Blend + New Bridge w/BART	Alt 6 RTP Blend + Airport/ Airport BART	Alt 8 RTP Blend + Dual Transbay Tube	Alt 11 RTP Blend + Rail Tunnel
Existing BART Tube	102,000	163,126	159,911	152,954	158,175	163,126	159,561
New BART Crossing/Rail Tunnel				12,785	16,132	2,738	6,265
ST: BART/RAIL SERVICE	102,000	163,126	159,911	165,739	174,307	165,864	165,826
Bay Bridge Bus	18,600	14,955	13,961	14,618	14,946	15,073	13,834
Hayward-San Mateo Bus	200	1,843	1,735	1,324	722	1,743	1,700
ST: BUS SERVICE	18,800	16,798	15,696	15,942	15,668	16,816	15,534
San Leandro-SF Ferry			marginal				
Alameda/Oakland-SF Ferry	700	775	919	866	912	893	860
Bay Farm Island-SF Ferry			911				
Berkeley-SF Ferry		108	482	126	128	128	126
Richmond-SF Ferry		707	1,074	798	839	839	727
Rodeo-SF Ferry			2,076				
Vallejo-SF Ferry	500	1,855	2,061	1,637	1,720	1,721	1,720
Martinez-SF Ferry			180				
Benicia-SF Ferry			434				
Oakland-Marin Ferry		185	20	20	20	20	20
Oakland Airport - SF Airport Ferry			43				
San Leandro-Oyster Point Ferry			24				
San Leandro-Coyote Point Ferry			132				
San Leandro-Redwood City Ferry			145				
ST: FERRY SERVICE	1,200	3,630	8,501	3,447	3,619	3,601	3,453
TOTAL TRANSIT PATRONAGE	122,000	183,554	184,108	185,128	193,594	186,281	184,813
INCREASE OVER RTP BLEND	n/a	n/a	554	1,574	10,040	2,727	1,259

Thus, the typical pre-earthquake transbay demand of about 102,000 passengers resulted in acceptable load factors, but increases in ridership since the earthquake have pushed current P.M. peak load factors to about 1.27.

BART's Extension Service Plan (ESP) will result in headway improvements which will decrease peak period headways from the current 3.75 minutes (17 peak hour trains) to 2.25 minutes (24 peak hour trains) in the future. Using today's travel demand pattern, the future seated capacity of the transbay tube would be approximately 140,000 daily trips, resulting in a total capacity of approximately 160,000 patrons at a policy load factor of 1.15.

Viewed in this context, the existing transbay BART tube could accommodate the Year 2010 demand shown in Table 4-4. Furthermore, the total transbay demand shown for Alternative 8 (dual transbay tube) is not high enough, in a practical sense, to justify a second tunnel parallel to the existing transbay tube. While Alternative 4 (new bridge with BART) and Alternative 6 (airport-airport BART) would attract modest patronage on the new facility, a significant proportion of trips would be diverted from the existing transbay tube. A similar situation occurs in Alternative 11 (rail tunnel).

Care must be used in interpreting patronage results. Firstly, the travel model is more time sensitive than capacity sensitive with respect to transit and does not reflect trade-offs which passengers may make to gain a seat on a train even with somewhat longer trip times. Thus, loadings in a new transit crossing may be considerably higher than shown in Table 4-4. Secondly, construction of a second bay crossing for BART would open up a whole new set of operating plan options, which may provide a secondary means for pursing a new crossing. Thirdly, a new BART crossing would increase the redundancy of the BART system and could allow for continued service to the Peninsula in the event service in the existing tube were suspended.

Bus Service

It should be noted that the travel model shows somewhat lower future bus volumes on the Bay Bridge than current counts indicate. The "missing" trips were probably assigned to the existing BART tube. (The travel model does not as readily reflect other factors such as specific schedules, transfers, and available seating capacity which govern the choice of transit mode.)

The travel model results do not show any significant difference in bus system patronage between either the RTP Blend or any of the bay crossing alternatives. It should be noted, however, that the BART "new bridge" patronage indicated in Alternative 4 could be interpreted as an indication of the patronage which could be attracted to a new bridge if express bus service were provided in an HOV lane prior to or in lieu of implementation of a BART connection.

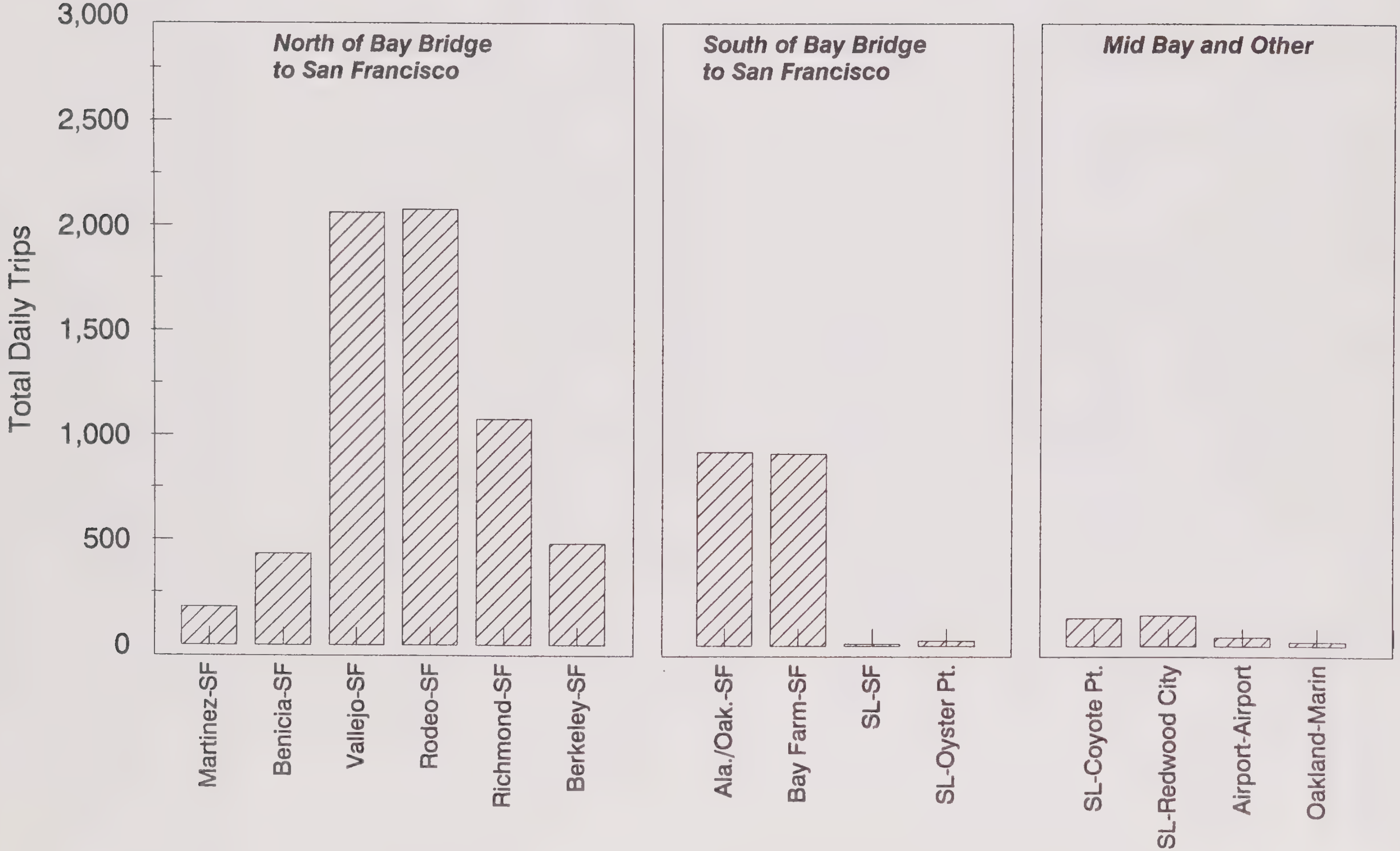
Ferry Service

Based upon the travel model results, enhanced ferry services tested in Alternative 1 could more than double the patronage attainable with the RTP Blend (and would be nearly an order-of-magnitude higher than current levels). The model indicates that much of the ferry patronage would be attracted from other transit modes and would not result in a significant increase in overall transit patronage. Improvements in the RTP Blend directly compete with ferry service. Most significant is the assumption of a continuous HOV lane from the Bay Bridge toll plaza up the I-80 corridor to the Carquinez Bridge. Until such a facility is constructed, ferry service levels to points north of the Bay Bridge could be many times the amounts indicated.

Ferry services have distinct geographical zones within which they are competitive. Figure 4-7 shows the projected daily patronage levels with services arranged into three geographical groupings. Highest patronage levels (at Rodeo and Vallejo) were obtained from points north of the Bay Bridge where significant amounts of I-80 congestion affect roadway travel times and where there are no BART services. South of the Bay Bridge, ridership was lower, but in Alameda where out-of-direction travel on the roadway system is necessary and no BART service is provided showed the highest ridership. The mid-bay and other routes were not located in prime travel markets and the model indicated very low ridership.

It should be noted that MTC and the City of Vallejo are studying enhanced ferry services in more detail. These studies will provide more refined patronage estimates.

Figure 4-7
FERRY SERVICE PATRONAGE
Alternative 1



Korve Engineering, Inc.

Travel Demand Sensitivity and Transportation Control Measures

As part of the travel analysis process, a "sensitivity" run was performed to test the impact of higher tolls on transbay vehicle demand levels. The toll sensitivity test assumed that current year tolls of five dollars would be collected from westbound autos on the Bay Bridge, New Bridge, San Mateo Bridge and Dumbarton Bridge. (Carpools of three persons or more would continue to be served toll free in the peak period.)

The travel sensitivity analysis was accomplished by modification of the toll cost on roadway links crossing the bay in the MTC travel model. The travel model, in determining the desired travel mode, destination and route, takes a wide variety of "travel cost" factors into account, including such things as the cost of CBD parking, auto operating costs, transit fares, highway travel time, transit access and transfer time. By changing the toll assigned to bridge links in the model, reduced highway volumes and increased transit boardings resulted.

The following conclusions resulted from these studies:

- Transbay total vehicle demand would decline by 6.5 to 13.2 percent;

- Transbay toll vehicle demand would decline by 8.5 to 16.9 percent (thus a quintupling of the toll would only result in collection of quadruple the revenue);

- Transbay transit patronage would increase by about 5 to 10 percent. This would further degrade BART's load factors which would already be at capacity, therefore increasing the need for a new BART crossing.

The decline in total vehicle demand would presumably be spread across all toll facilities. The sensitivity test was based upon work trips and did not specifically determine either the time during the day nor type of trips which would be shifted to transit. Presumably, discretionary trips such as shopping trips would be most heavily discouraged, with commute trips affected moderately, and least impact on business travel which could not be avoided. For these reasons, it is difficult to predict the impact higher tolls would have on peak period Bay Bridge congestion, although there would be some relief.

MTC has recently developed and adopted a Transportation Control Measure (TCM) Plan designed to address state and federal air quality requirements. The adopted plan is expected to result in a 5 percent reduction in vehicular demand regionwide and is essentially included in the RTP Blend which was a baseline condition for the bay crossing alternatives. Contingency measures which may be adopted if necessary could result in a further reduction of daily vehicular demand regionwide of 19.6 percent. Adoption of contingency measures could therefore reduce somewhat the projected vehicular volumes and result in an increase in transit demand.

Land Use Sensitivity

Year 2010 travel forecasts accomplished for this study were based upon the Association of Bay Area Governments (ABAG) approved the Year 2005 land use projections which are incorporated in the MTC travel model. Clearly, transportation demand is closely related to land use assumptions. In this regard, the following points should be noted:

- ABAG projections show greater increase in employment in San Francisco County than in San Mateo County by the Year 2005. (A 90,000 increase in San Francisco is projected by 2005, versus an increase of 75,000 in San Mateo County.) Since some of the San Mateo growth would be in southern San Mateo County and therefore better served by the existing San Mateo Bridge, it is apparent that the land use forecast is a major reason why the new bridge did not attract as much travel as expected.

  While San Francisco has not in recent years kept pace with the growth trendline indicated in ABAG projections, year-to-year employment growth depends heavily upon near-term economic conditions. It should be noted that ABAG employment growth projections for San Francisco are conservative compared to numbers which have been discussed in connection with potential major projects in that city.

- Future year travel continues to be heavily weighted towards a westbound-A.M./eastbound-P.M. peak condition. Clearly, changes in land use which would result in relatively higher levels of employment in the East Bay, with correspondingly higher levels of housing in the West Bay, could potentially make

use of existing capacity in the "non peak" flow direction on existing bay crossing facilities (transit as well as highway).

- An "infill" alternative land use land scenario was run by MTC for the RTP. This alternative land use provided about 6 percent more households in the Bay Area region, concentrated around existing and proposed rail commuter facilities, as opposed to allowing such housing to take place outside of the area. (No change in employment was considered.)

  The result of this test indicated that, while transit ridership would increase by about 12 percent, highway volumes would also increase about 4 percent regionwide. This land use was also found to increase transbay trips by an additional 6 percent over levels projected in the RTP Blend, further straining the capacity of the BART transbay tube and existing highway crossings.

Longer-Term Travel Demand

Although there is significant peak period congestion on the Bay Bridge and current BART load factors are at capacity in the peak hour on key transbay lines, it is apparent that overall bay crossing demand by the Year 2010 could be served by the total capacity available on all transbay facilities in the study area: The peak period on the Bay Bridge would continue to extend and additional BART capacity would be provided by more frequent service in the existing transbay tube.

The funding analysis for a new bay crossing facility assumed collection of increased tolls in a 30-year period ranging from the Year 2000 through the Year 2030. While the Year 2010 demand levels will push highway and BART to capacity for trips to San Francisco, continued growth in employment in that city will require additional bay crossing capacity. If, for example, currently-projected growth rates continue over the longer term, another highway and/or transit crossing will be essential.

Unfortunately, detailed, land use-driven travel forecasting procedures have not been developed for the post-Year 2010 period. However, since it is apparent that increases in travel demand are likely to occur after the Year 2010, and since the BART tube and Bay Bridge would be essentially

at capacity in Year 2010, it is important that longer-term land use and travel forecasts be developed in support of more detailed analysis of transbay highway and transit projects which may be more feasible and necessary in the next century.

5. IMPACTS REPORT

SECTION 5
ENVIRONMENTAL AND SOCIO-ECONOMIC REPORT

5.1 INTRODUCTION

The purpose of this report is to provide a generalized evaluation of the relative environmental and social/economic effects associated with each of the bay crossing alternatives. This is one of a series of reports being prepared to assist decision makers, committee members, and the public in their assessment of each of the five alternatives.

The analysis is divided into three sections. The first section discusses environmental considerations, including ecology, with emphasis on potential impacts on wetlands, geology and impacts due to susceptibility to groundshaking, dredging and resulting water quality impacts, noise and air quality. The second section focuses on socio-economic considerations including consistency with regional and local plans and zoning, land use impacts focusing on potential for displacement of housing units or businesses, impacts on the visual environment, and construction impacts. The final section includes a discussion of growth inducing impacts associated with each of the five alternatives. Figure 5-1, indicating the location of potential impacts, is located at the end of Section 5.2, Environmental Considerations and Figure 5-2, indicating land use impacts is located at the end of Section 5.3, Socio-Economic Considerations.

The approach to this assessment is to present a general overview of key issues, plans, and policies. Some of the impacts identified can be mitigated; however, for purposes of this study "pre-mitigation" or worst-case conditions have been assumed for each of the topics discussed. For example, Alternative 4 does not assume that a sound wall has been constructed in the evaluation of noise and visual quality impacts. It is important to reiterate that this is *not* an environmental impact report. As an overview document, the analysis has made extensive use of existing reports and data, reviewing existing reports and plans, augmented by personal interviews with key agencies and organizations.[1]

---

[1] See Appendix A for a list of persons and organizations contacted.

5.2 ENVIRONMENTAL CONSIDERATIONS

Ecology

Introduction and Setting

San Francisco Bay is one of the nation's major estuaries. Including San Pablo and Suisun Bays, it has a surface area of about 435 square miles and about 275 miles of shoreline at mean sea level. Major inflow into the Bay and Delta is provided by the Sacramento and San Joaquin Rivers. Together they drain approximately 3,500 square miles, about 40 percent of California's land area.

Much of the Bay is shallow, with an average depth of 20 feet and with only 15 percent having a depth greater than 30 feet. Prior to the late 1800s, San Francisco Bay contained more than 150,000 acres of tidal salt marsh and additional seasonal wetlands above the tideline that were regularly flooded during the annual winter rains. The Gold Rush and Statehood in the mid-1850s marked the beginning of rapid settlement, population growth, and land development in California resulting in direct and indirect effects on the Bay ecosystem. Tidal marshes and unvegetated portions of the Bay were diked and filled for urban development, salt production and agriculture. Hydraulic mining for gold in the Sierra Nevada in the 1850s and 1860s resulted in particularly large increases in sedimentation. Expanding agricultural development in the Central Valley and urban development around the Bay have led to significant diversions of freshwater from the rivers flowing into the estuary.

The cumulative effect of a century and a half of human development around the Bay and in the Central Valley has resulted in a 6 percent reduction of the water surface of the Bay, and an estimated 83 percent reduction in the acreage of tidal marshes.[1] Many of the tidal marshes were diked for agricultural uses or converted to salt ponds around the turn of the century. These areas became seasonal wetlands, flooding during the winter rains, and drying during the summer months. In the post-World War II era many of the seasonal wetlands were filled or modified to support urban development. Between 1956 and 1988, seasonal wetlands south of the Bay

---

[1] U.S. Fish and Wildlife Service, *Concept Plan for Waterfowl Protection, San Francisco Bay*, November 1989, p. 17.

Bridge declined by 61 percent, from 17,854 acres to 7,365 acres. The trend is continuing, as projects now planned in San Francisco Bay could remove more than 30 percent of the functioning seasonal wetland acreage that remains.[1]

Wetlands provide essential habitat for migratory waterfowl and other waterbirds. San Francisco Bay is one of the most important coastal wintering and migrational areas for Pacific Flyway waterfowl populations. Midwinter duck populations have averaged 220,980 in recent years, accounting for 7 percent of all ducks in California and over 40 percent of the populations of diving ducks and sea ducks.

In addition to waterfowl, numerous wintering and migratory shorebirds make use of the mudflats, salt ponds, and other wetland habitats around the Bay. Springtime shorebird census counts have approached or exceeded 1,000,000 birds in 1988 and 1989. The Bay has been designated a Hemispheric Site by the Western Hemisphere Shorebird Reserve Network.

Wetlands and adjacent uplands also provide habitat for 14 federally-listed endangered plant and animal species and two threatened species. Furthermore, ten Species of Special Concern that inhabit wetland areas around the Bay have been identified by the State.[2] The most prominent of the endangered and threatened species include the California Clapper Rail, California Least Tern, Salt Marsh Harvest Mouse, Black Rail, and the San Francisco Garter Snake.

<u>Regulatory Framework</u>

The environmental importance and sensitivity of San Francisco Bay is recognized, in varying degrees, at all levels of government while a number of citizen groups and environmental organizations are very active in the preservation of the Bay's remaining natural values as well as the restoration of some of the habitat values that have been lost or degraded in the past 150 years. The regulation of bay fill, the regulation and management of wetlands and the regulation of the quantity of inflow and the quality of Bay waters is carried out by a large and very complex network of agencies and permitting authorities. A proponent of a project that may affect

---

[1] Stephen Granholm, *Endangered Habitat, A Report on the Status of Seasonal Wetlands in San Francisco Bay*, July 1989, p. 37.

[2] U.S. Fish and Wildlife Service, op. cit. p. 7, and Appendix C.

wetlands, place fill or structures in the Bay waters, or affect water quality faces a lengthy and rigorous permitting process, with an array of players and complex rules, entailing extensive reports, meetings, and public hearings.

The fact that a project proponent is itself a public agency, and that the project would serve a recognized public interest or need, will, in some cases, modify the applicable permitting standards. However, public proponents are not exempt from any of the major regulatory requirements. Indeed, a new bay crossing facility would be a very significant, high-profile project and would receive intense scrutiny at all levels of the permitting process.

The following is a summary of the key laws, regulations, and related permit requirements designed, in whole or in part, to protect the Bay's ecological values with potential applicability to a new bay crossing project:

Federal Government

The Army Corps of Engineers operates a permit program under *Section 10 of the River and Harbor Act of 1899, Section 404 of the Federal Water Pollution Control Act* and the *1977 Clean Water Act Amendments*. The permits apply generally to filling, the placement of structures, dredging, or diking in all waters of the United States and adjacent wetlands. The issuance of permits is based on an evaluation of probable impacts with project benefits weighed against foreseeable detriments. A permit decision should reflect the national concern for both the protection and utilization of important resources, and take into consideration conservation, economics, aesthetics, general environmental concerns, historical values, fish and wildlife values, water quality, energy needs, and, in general, the needs and welfare of the people. The extent of the public need and the availability of alternative locations and/or methods to accomplish the objectives of the proposed project are always considered.

The Corps regulations recognize that wetlands are vital areas and that numerous small projects can have a significant cumulative effect on important wetland resources. The project justification, its location, and the availability of alternatives become particularly important when wetland resources may be affected.

Under the *Fish and Wildlife Coordination Act*, the *Endangered Species Act*, the *National Environmental Policy Act* and other related laws, the U.S. Fish and Wildlife Service reviews federally-permitted or funded projects with the goal of protecting and restoring fish, wildlife, and natural values of waters and related wetlands. Formal consultation and mitigation is required if a project could affect endangered or threatened species or their critical habitat.

The Environmental Protection Agency and the National Marine Fisheries Service review permit applications and provide comments and recommendations on whether permit applications to the Corps should be approved or denied. In addition, the EPA has oversight authority over the Section 404 permit program and can veto a Corps permit approval if it finds the impacts unacceptable. The Coast Guard regulates the construction and operation of bridges and will comment on Corps' public notices pertaining to navigation and pollution matters.

The *National Environmental Policy Act* requires the preparation of an Environmental Impact Statement (EIS) on major federal actions. Major transportation projects with federal funding or major projects requiring Section 10/404 Permits form the Corps of Engineers often require EISs.

State of California

The Department of Fish and Game policy on wetlands is drawn from the *Wetlands Preservation Act of 1976*, which identifies a "need for affirmative and sustained public policy and program directed at wetlands preservation, restoration and enhancement in order that such wetlands shall continue in perpetuity. Senate Concurrent Resolution 28 in 1978 sets a policy of increasing the area of the State's wetlands by 50 percent before the Year 2000.

While funding has been limited for the acquisition of wetland areas and progress toward restoration of wetland has been limited, the Department of Fish and Game and other departments in the State Resources Agency have been following specific guidelines contained in the State Wetlands Policy (1987) for the retention of wetland acreage and habitat values. The policy sets a hierarchy of preferences for mitigation of the loss of wetland acreage. The highest preference is for in-kind, on-site compensation, followed by in-kind, off-site compensation. If these are not possible, then compensation in the form of a different kind of wetland can be considered for avoidance of a net loss of acreage. Fish and Game and other Departments use these policies in reviewing projects that require state and federal approvals.

The Regional Water Quality Control Board acts as an agent of the State Water Resources Control Board and the Federal Environmental Protection Agency under the Clean Water Act for the issuance of a Water Quality Certification (401 Permit). Water Quality Certification is required for all projects requiring Section 404 permits from the Corps of Engineers. Under recent policies adopted by the San Francisco Bay Regional Board, no net loss of wetlands will be allowed. While this policy is in litigation and has yet to be implemented, it demonstrates the Regional Board's intent to conduct a stringent review of permits involving the filling of wetlands or the degradation of wetland habitat values.

The Bay Conservation and Development Commission (BCDC) was created in 1965 by the *McAteer-Petris Act* to implement a comprehensive plan for the conservation of San Francisco Bay waters and the regulation of shoreline development. The Commission regulates dredging and filling in the Bay, including piers and pilings. It's jurisdiction extends 100 feet inland of the shoreline but does not extend onto diked historic baylands. BCDC issues permits in accordance with the standards set in the Act, and has been very effective in reducing the rate of filling activities within the tidal margins of the Bay. It has not had a major role in the regulation of seasonal wetlands, where almost all of the loss of wetland habitat occurred in the '70s and '80s.

The *California Environmental Quality Act* requires the preparation of an Environmental Impact Report (EIR) on any project that may have a significant effect on the environment. One agency involved in a specific project becomes the "Lead Agency" for the preparation of the report. For any of the bay crossing alternatives the Lead Agency would probably be a transportation agency, such as Caltrans, BART, or MTC. The EIR requirement does not eliminate the need for any of the federal or state permits, and in fact, is often a prerequisite for the processing of a permit application. Both federal and state regulations have provisions allowing the joint preparation, and sometimes, processing of EIRs and EISs.

Issues Raised by the Five Alternatives

Alternative 1: High-Speed Ferry System

With this alternative a fleet of catamaran ferry boats with cruising speeds of up to 30 knots would ply the Bay waters, providing regular service between 17 ferry terminals. Seven of the terminals now have Ferry Service or had it in the post-earthquake months (San Francisco Ferry Terminal, Oakland, Alameda, Vallejo, Richmond, Berkeley, and Bay Farm Island[1], while five of the probable terminal locations would be in existing ports or marinas (Martinez, Rodeo, San Leandro, Oyster Point Coyote Point, and Redwood City).

The construction of a new terminal, with new docks, ticketing facilities, passenger shelters, and parking lots would be required at almost all of the 17 sites. If new facilities are not required, a major upgrading of existing facilities can be expected. BCDC and Section 10/404 permits will be required for facilities at each of the 17 sites. Potential impacts on ecological values, particularly wetland habitats, could become an issue at five of the sites, and could affect the design or location of the terminal facilities and the upland parking facilities. Potential terminal sites located close to existing tidal wetlands include Benicia, Martinez, Oakland Airport, and the San Leandro Marina. The Bay Farm Island approach channel is adjacent to existing eelgrass beds. Monitoring is proposed to ascertain if the ferry operation will cause long-term impacts on this resource.

Since the success of the ferry operations will be dependent, in part, on the ease of access, the designers can be expected to propose parking close to the terminals. Similarly, new access roads and bus terminals can be expected at every location. These requirements could lead to conflicts with existing seasonal wetlands, which would in turn require a thorough review of alternatives and/or the development of mitigation and compensation programs. Sites where conflicts with diked historic wetlands or other non-tidal wetlands are most likely to arise include San Leandro, the Oakland Airport, Bay Farm Island, Martinez, and Benicia.

---

[1] Bay Farm Island has had experimental ferry service for feasibility and environmental testing over the past several years.

Ferry operations near the bayshore and within channel areas can be constrained if slow speed limits are imposed to mitigate potential impacts related to shoreline erosion or damage to sensitive areas from the boat's wakes. However, this is not expected to be a major issue with this alternative because the catamarans create moderate wakes, and most of the East Bay shoreline is protected from storms that generate much greater wave energy than ferry operations.

In Benicia, Martinez, Bay Farm Island and possibly, the Oakland Airport, the boat docking facilities may require an extra measure of protection from exposure to the weather and high waves. These facilities would require more pilings and/or bay fill and would receive closer scrutiny from the permitting agencies.

In general, however, there is sufficient flexibility in the siting and design of the proposed ferry terminals so that significant impacts on the ecological values of the Bay can be avoided.

Alternative 4: Interstate 380 to 238 Bridge Connection

This alternative would be a major new structure across the Bay, pile supported approximately 15 feet above the water for most of its length, rising to a height of about 140 feet to cross the main shipping channel. It would carry both vehicles and BART trains.

At the West Bay end, the bridge would come ashore north of the San Francisco Seaplane Harbor near the mouth of Colma Creek. The BART alignment would separate from the road alignment about 4,000 feet east of the shoreline. The BART alignment would cross about 1,500 feet of intermittently exposed mudflat (NWI Classification E2USN[1]), the Colma Creek Channel, and a small area (less than one acre) of vegetated tidal marsh (E2EMN). The proposed station location near South Airport Boulevard would affect 1-2 acres of diked seasonal wetland and excavated seasonal pond. (PEMCh and PUBKHx).

---

[1] The project alignments were checked for potential wetland involvement using the applicable National Wetlands Inventory (NWI) maps. The classification system is quite complex and will not be described in this report. The NWI codes, however, will be shown in parentheses for the benefit of readers familiar with the classification system. A schematic of the classification is found in Appendix B.

The bridge structure would follow the regularly flooded shoreline area to a crossing of South Airport Boulevard. The interchange with I-380 could affect 2-5 acres of tidal marsh (E2EMN and E2EMP) and a small area of diked vegetated wetlands (PEMCh). The endangered San Francisco Garter Snake has been found in seasonal wetlands near the Airport.

At the East Bay end, the bridge would cross about 2,000 feet of intermittently flooded mudflats, (E2USN) and then would follow the levees forming the banks of the Estudillo Canal for about a mile. It would pass over the Tony Lema Golf Course and to the north side of the City of San Leandro's dredge spoils disposal site and the site of a proposed, and very controversial, Citation Homes housing project. Approximately 225 acres of the 471 acre area are intermittent wetlands, some tidal and some seasonal (E2EMCh and PEMCh). Salt Marsh Harvest Mice, an endangered species, have been found on this site. This site is also being considered as a potential addition to the San Francisco National Wildlife Refuge.[1]

An alternative Alignment, 4A, would make a landfall about 1.6 miles to the south and would generally follow San Lorenzo Creek to the vicinity of I-880. This alignment would cross almost a mile of tidal mudflats and could affect areas of San Lorenzo Creek which is partly tidal marsh (E2EMN) and partly tidal creek (R1UBV).

Since the bridge structures with both the primary and alternative alignments would be elevated until they pass over the Southern Pacific tracks, neither alternative would result in a total filling of the right-of-way within the affected wetland areas, although the short-term construction impacts could become a major concern.

Alternative 6: BART Airport Connection

This Alternative entails the construction of a new BART tube beneath the Bay between the San Francisco and Oakland International Airports. In addition to the potential for adverse ecological impacts from the landward activities, the dredging that would be required to construct the tube could have ecological impacts. Dredging is discussed separately, in Section 2.3 of this report.

---

[1] U.S. Fish and Wildlife Service, *Final Environmental Assessment, Potential Additions to the San Francisco Bay National Wildlife Refuge, Alameda, San Mateo and Santa Clara Counties, California*, March 1990, p. 15 and Map, Appendix D. The site is Tract #229.

At San Francisco Airport, Alternative 6 would connect with the planned BART station near the Southern Pacific tracks, and would descend below ground in a right-of-way parallel to the existing tracks. It would cross beneath US 101 well below the ground surface and would remain subsurface and submerged for the full width of the Bay.

On the East Bay side, the BART tunnel would pass beneath the runways and the Airport terminal, emerging about 1,000 feet east of the circular drive serving the terminals. A diked, seasonal wetland (PEMCh) is located south of Airport Boulevard at this location, a small portion of which could be affected. As the alignment turns south it follows the Southern Pacific right-of-way until it reaches the Estudillo Canal, where it turns to the east, south of Manor Boulevard. The crossing of the Estudillo Canal is near the same location noted for Alternative 4, above, although the likelihood of impacts on wetlands is less with this Alternative because it follows the railroad alignment rather than the canal alignment.

Alternative 6 has less potential for adverse impacts on wildlife resources than Alternative 4, because it would be in a tube beneath the Bay and would surface at upland locations more than 1,000 feet from the shoreline. Construction of this Alternative would be a major undertaking involving large staging areas at either end and extensive work in the Bay waters and along the full length of the right-of-way.

Alternative 8: BART Transbay Tube

This Alternative calls for the construction of a second BART tube beneath the Bay parallel to the existing BART tube. It would be constructed beneath the ground in San Francisco and through downtown Oakland, although cut-and-cover will be used for the construction of stations, where feasible. It would surface near where the present BART tube surfaces in the East Bay and would pass through an expanded Oakland West Station. In total, this alternative would be above ground, on aerial structures, for only about 2.1 miles of its 10.9 mile length.

The area it would pass over has been industrialized as a rail and shipping terminal for over a century and is of little ecological importance. Surface impacts are not likely to be significant.

Construction of a new BART tube would require substantial dredging. When the existing BART crossing was constructed in the late 1960s, over 5.7 million cubic yards was disposed of at an

ocean site 1.1 miles west of Seal Rock. At the time, potential environmental impacts were not anticipated, reported or mitigated, and the environmental impacts of dredging operations were not evaluated as a part of the permitting process.

Alternative 11: Inter-City Railroad Tunnel

Alternative 11 would entail the construction of a tunnel for transbay rail service between the Port of San Francisco and the Port of Oakland. The tunnel would be large enough to accommodate double-stack container freight cars and would have the capability of running CalTrain passenger trains, as well. The facilities would be in a subway on the San Francisco side beginning beneath the present Southern Pacific yard adjacent to Townsend Street. The tunnel would cross the Bay averaging about 20 feet below the bay bottom. It would surface on the north side of the Oakland Inner Harbor channel, connecting to existing rails in the Union Pacific Yard at the Port of Oakland.

The potential for adverse ecological impacts from this Alternative is essentially the same as for the BART transbay tube. The surface mounted portions of this Alternative would pass through a heavily industrialized area with little ecological value. Significant impacts are unlikely.

Geology

Introduction and Environmental Setting

The San Francisco Bay estuary was formed during the last 10,000 years when a rapid rise in sea level following the last ice age inundated the alluvial valley of the Sacramento River. As it grew in area and depth it formed a settling basin for fine sediment carried into it by streams and rivers. This sediment, chiefly clay and silty clay, was first deposited along the course of the primitive estuary as bottom mud. Later, as the sea level stabilized near its present position, salt marsh deposits accumulated between the level of high and low tides. These deposits grew outward from the shore until a belt of marshlands, several miles wide, fringed much of the prehistoric bay. Over time, as much as 120 feet of Bay Mud accumulated in some places.

In historic times the size of the Bay has been reduced significantly. Up to 60 percent of the marshlands surrounding the Bay and large areas of open water (53 square miles or 11 percent)

have been removed from tidal influence as a result of human activities -- land fill, diking and reclamation for agriculture, dredge disposal, and accelerated sedimentation, primarily from hydraulic mining. In the Central Bay, most of the land that was filled and reclaimed has been devoted to urban uses including airports, seaports, military bases, railroad yards, industrial facilities, transportation corridors, marinas, and others.

Inland from the Bay, and below the slopes of the surrounding hills that form the Coastal Range, are found the Lowlands -- by far the most intensively populated and urbanized geologic province of the region. The lowland areas are formed primarily of alluvial gravels, sands, and silts formed over tens of thousands of years as streams have transported sands and gravels from the hills above and deposited them on the more level slopes below. The lowland areas around the Bay have become intensively used because of their convenience and accessibility. The level or gently sloping surface and low relief provides excellent building sites, level routes for roads and railroads, and is more convenient for utility systems. Historically, the lowlands also offered good land for agriculture, abundant water at shallow depths, and proximity to port facilities.[1]

In addition to the processes of erosion and sedimentation that have formed the soils and near-surface geology of the Estuary and surrounding Lowlands, frequent earthquakes along major active faults traversing the Bay Area provide readily perceived and potentially very disastrous geologic forces. San Francisco Bay is located between the active San Andreas and Hayward Faults. The San Andreas is capable of an 8.3 Richter magnitude earthquake while the Hayward Fault is capable of a 7.5 magnitude earthquake. Recent estimates indicate that there is a 67 percent chance that the Bay Area will experience a magnitude 7 or higher earthquake in the next 20 years. It is also projected that such an earthquake would be much more damaging than the October 17, 1989 Loma Prieta Earthquake because it would likely be located closer to populated areas.[2]

The new facilities and structures associated with the bay crossing alternatives would all be constructed within the boundaries of the Estuarian or Lowlands geologic provinces. The Bay and

---

[1]Brown, R.D. and Kockelman, W.J., *Geologic Principles for Prudent Land Use, A Decisionmakers' Guide for the San Francisco Bay Region*, U.S. Geological Survey Professional Paper 946, pp. 7-14, 22-30.

[2] U.S. Geological Survey, *The Next Big Earthquake May Come Sooner Than You Think*, San Francisco Examiner, September 9, 1990, p. 15.

upland areas that were formerly marshlands, are underlain with Bay Mud ranging in thickness from a few inches to many tens of feet. Because this mud is unconsolidated, high in organic matter, and saturated with water, its bearing strength is so low that it fails under even a moderate load.

Although no active earthquake faults would cross the alternative alignments, groundshaking from earthquakes on sites underlain with Bay Mud averages two to four times greater[1] and lasts longer than on sites of bedrock. Where sand or silt beds in the mud are saturated, the sediment may liquefy and cause ground failure.

Many of the difficulties presented by construction on sites underlain with Bay Mud can be overcome with advanced engineering supported with thorough geologic investigations and the use of specialized construction techniques. These add significantly to the cost of development, but are trifling when compared to the economic and societal costs of losing a major transportation lifeline as the result of an earthquake.

The alluvium underlying the lowland areas is older and more consolidated than are the Bay Muds and generally provide a much more stable and stronger base to support structural loads. The youngest, and most extensive, of these deposits are found near the fringe of the Bay and present stream courses. They are less consolidated, weaker under load, more likely to have a shallower water table, and support younger and less mature soils than does older stream sediment.

Groundshaking from earthquakes on sites in the lowland areas is generally less intense than on sites underlain with Bay Mud. However, the susceptibility to groundshaking is locally variable within this geologic province and can be very strong or violent at locations underlain by younger deposits near the Bay and close to large streams.

---

[1] Governor's Board of Inquiry on the 1989 Loma Prieta Earthquake, *Competing Against Time*, May 1990, Finding 4, p. 45.

Issues Raised by the Five Alternatives

Alternative 1: High-Speed Ferries

The proposed ferry terminals would be dispersed among 17 locations around the Central and North Bays. All of the terminals would be constructed on sites underlain with Bay Mud and would be susceptible to very strong or violent groundshaking in the event of a major earthquake on the Hayward or San Andreas Fault systems in the Bay Area.[1] Damage to structural components at some of the terminals could occur and access roads and utility systems would also be damaged, in varying degrees.

The ferry boats could continue to operate after an earthquake, however. They would probably provide a major transportation lifeline immediately following a large earthquake, as they did following the 1906 and 1989 earthquakes. In the subsequent weeks and months, the ferries would continue to provide essential transportation while other systems remain closed for repair or even demolition and replacement. The success of the *ad hoc* ferry system developed in the weeks following the Loma Prieta Earthquake attests to their potential benefits in an earthquake emergency.

Alternative 4: Interstate 380 to 238 Bridge

Approximately 15.1 miles of the 16.6 miles of bridge and approach connectors required with this alternative will traverse geologic units with very high to extremely high susceptibility to groundshaking in the event of an earthquake. The maximum groundshaking intensities that could occur along the length of this facility would be very strong to violent, except for a short section of the facility in the East Bay between the Southern Pacific tracks and I-880. Strong groundshaking could occur in this area.

It is assumed that the bridge structures would be constructed of reinforced concrete and steel components, and carefully engineered. The ABAG Cumulative Damage Potential maps indicate

---

[1] Ratings of susceptibility to groundshaking, intensity, and damage potential found in this section are derived from: Perkins, J.B., *On Shaky Ground*, ABAG, February 1987. Maps used include *Geologic Units*, *Maximum Groundshaking Potential* and *Cumulative Damage Potential for Concrete and Steel Buildings*.

that concrete and steel structures would have a moderately low to high risk of damage along this alignment. The high risk area is the area near the shoreline in the East Bay, where softer Bay Mud predominates. It is noteworthy, however, that the ground amplifications experienced on soft soils in the Loma Prieta Earthquake were at least twice what would have been predicted by the attenuation relationships commonly used in the current building codes.[1] This would indicate that the damage potential may be understated.

It should be noted that while the 50-year old Bay Bridge suffered structural damage in the Loma Prieta Earthquake, which was considered mild to moderate, the San Mateo Bridge suffered only slight damage and was closed only a short time for inspection and repairs. The Dumbarton Bridge and the BART system, including the transbay tube and all the elevated structures, suffered no damage. BART service was interrupted because of the lack of power and the need for inspection. While this experience shows that modern engineering and design can greatly improve the earthquake survivability of major transportation links, even when built on shaky ground, it also foreshadows the difficulty of repair and the high disruption potential and social costs that can be expected when important links in the transportation system break during the next major earthquake.

Alternative 6: BART Airport Connection

In the West Bay, Alternative 6 would have approximately 1.2 miles of elevated and transition structures constructed on geologic units with very high to extremely high susceptibility to groundshaking from earthquakes and with potential maximum intensities of groundshaking classified as violent to very violent. The ABAG Cumulative Damage Potential maps indicate very high cumulative damage potential for concrete and steel structures along the west side of US 101 where the BART alignment is elevated and where the Airport BART station is proposed.

The BART tube beneath the bay waters (about 14 miles) would have a lower risk of damage from groundshaking because of its flexibility, buoyancy, and location in a higher density medium (water). In many locations it would also be founded on older, more consolidated Bay Mud.

---

[1] Governor's Board of Inquiry, op. cit., Finding 34, p. 61.

In the East Bay, Alternative 6 would have about 6.4 miles of above-ground structures mounted on geologic units with susceptibility to groundshaking ranging from moderately high to extremely high. The maximum groundshaking intensity that can be expected in these locations ranges from strong to violent. The Cumulative Damage Potential for concrete and steel structures is estimated to be very high in the area of the Oakland Airport Terminal where the underground station would be constructed and where the transition structure would be located.

The design and construction of BART facilities in areas with such high susceptibility to very significant groundshaking during an earthquake requires state-of-the art structural engineering and seismic design. Designing structures to resist expected groundshaking forces is a feasible goal and has been embraced by BART. The District has developed and updated systemwide structural design criteria. They may be updated again in conjunction with currently proposed BART extensions.[1] These criteria require engineering knowledge of the site-specific geologic conditions along each alignment and appropriate foundation and structure designs to reduce the risks of earthquake damage to acceptable levels.

Alternative 8: BART Transbay Tube

Alternative 8 parallels the existing BART transbay tube between San Francisco and downtown Oakland. It passes through geologic units with moderately high to extremely high susceptibility to groundshaking, with strong to violent potential maximum groundshaking, and with a moderately low to a high risk of groundshaking damage to concrete and steel structures. Only about 1.9 miles out of 10.9 miles of this alignment would be surface mounted. Like all the alternatives, it would not cross any active faults. Based on the alignment through zones with somewhat lower maximum cumulative damage potential and the reduced length of above-ground structure, this Alternative is judged to have a somewhat lower potential for impacts from geologic forces than Alternative 6.

---

[1] BART, *Draft Environmental Impact Report, Dublin - Pleasanton Extension Project*, September, 1989, p. 4-94.

Alternative 11: Inter-City Railroad Tunnel

Like Alternative 8, Alternative 11 runs from near downtown San Francisco to Oakland. It passes through geologic units with high to extremely high susceptibility to groundshaking, with very strong to violent potential maximum groundshaking, and with a moderately low to a high risk of groundshaking damage to concrete and steel structures. About 2.5 miles out of 7.5 miles of this alignment would be surface mounted. It would not cross any active faults.

Dredging and Water Quality

Introduction and Environmental Setting[1]

The development and maintenance of boat harbors, shipping channels, and submerged transit facilities (BART) has required dredging activity in the San Francisco Bay estuary for over 120 years. The first Congressionally-authorized dredging began in 1868. Since the 1930s, a number of projects have resulted in almost continuous dredging, although there has been a wide variation in the amount of dredging occurring from year to year. In 1986 and 1987, an annual average of 7.282 million cubic yards (mcy) was dredged from the entire estuary, of which an average of 6.669 mcy (92 percent) was from the Bay itself, while an average of .613 mcy (8 percent) was from the Delta. Approximately 75 percent of this work was for maintenance dredging and 25 percent was for new work, primarily Phase II of the John F. Baldwin Ship Channel project.

Dredging activities in the Bay are primarily controlled by the U.S. Army Corps of Engineers, along with the U.S. Environmental Protection Agency (EPA), the Bay Conservation and Development Commission (BCDC), and the Regional Water Quality Control Board (RWQCB). In addition, the Coast Guard, the State Water Resources Control Board, and various other state and local agencies have jurisdiction over certain activities related to dredging.

The Corps of Engineers dredges those projects that are maintained by the Federal Government, and grants permits to other entities for the disposal of dredged material in inland waters or the

---

[1] The background information in this section is from: San Francisco Estuary Project, *Status and Trends Report on Dredging and Waterway Modification*, March 29, 1990.

ocean. The RWQCB is empowered to verify that water quality standards will not be violated through the Water Quality Certification process under the *Federal Water Pollution Control Act*. BCDC issues permits under the *McAteer-Petris Act* provisions and requires that all projects be consistent with the Coastal Zone Management Plan adopted by the state under the Federal *Coastal Zone Management Act*. The permitting process is lengthy and complex, and could take five years or longer for the Alternatives requiring large amounts of dredging.

Most of the dredge spoils (approximately 88 percent in 1986 and 1987) removed from the Bay are disposed of at one of three approved aquatic disposal sites -- the Alcatraz site, located south of Alcatraz Island, the Carquinez Strait Disposal site located west of Carquinez Bridge, and the San Pablo Bay site, located between Point San Pedro and Pinole Point. Dredge spoils that are not dumped at one of these aquatic sites are disposed of at upland sites, primarily in the Delta and at locations set aside for boat harbor maintenance work, e.g., near the San Leandro and Martinez marinas.

In 1986 and 1987, about 81 percent of the dredged material disposed of in the Bay was dumped at the Alcatraz site, while 14 percent went to the Carquinez site, and 5 percent went to the San Pablo Bay site. These sites were officially designated by the Corps of Engineers in 1972, although they have been in use for much longer. Prior to 1972, however, there were a number of other active disposal sites in the Bay, and in ocean waters west of the Golden Gate. One of these sites, 1.1 miles west of Seal Rock, received the dredge spoils excavated for the BART tube in the late 1960s. Ocean disposal sites have not been used since 1972, but are currently under consideration for future large dredging projects in the Bay.

For many years there was little or no concern about the potential adverse environmental effects from dredging activities, and very limited scientific data on the effects of dredging. In the 1970s, the Corps of Engineers conducted research along a number of lines of inquiry in the Dredge Disposal Study. It was followed with additional research under the Dredged Material Research Program. In 1984, the Corps established a Dredged Material Disposal Management Program which continues today. Key questions that have been the focus of the research, and from which the future regulatory requirements will be derived, include: What is the fate of the disposed dredged material? How is it dispersed? How does dispersion affect bay water quality? What types of contaminants are unlocked from the bay bottom and dispersed during dredging? What effects do dredged materials have on aquatic biota, including plankton, invertebrates, and fishes?

As the research continues and the answers to these questions become more focused, they will certainly affect the management options chosen by the Corps in the issuance of dredging permits. Trends that appear to be developing include the imposition of some limitations on in-bay disposal and a reopening of ocean disposal options. In order to reduce the potential effects from dredging on biotic resources, restrictions have recently been imposed by the RWQCB on dredge disposal during certain fish migration and spawning periods. In addition, restrictions on the daily and annual maximum disposal amounts at the three disposal sites and the development of special requirements for the more contaminated dredge spoils, is also likely. The development of specific requirements to mitigate the potential adverse impacts from dredging can be expected to increase the unit cost of future dredging work, by an unknown, but possibly significant, amount. Annual limitations could also affect the construction periods of some major projects.

<u>Issues Raised by the Five Alternatives</u>

Alternative 1: Ferry System

Existing natural or dredged channels serve most of the 17 proposed ferry terminal sites. Four of the sites would be located in existing marinas that may need additional dredging to serve the ferry slip and/or provide a more efficient access/turning basin. These marinas are Berkeley, San Leandro, Coyote Point, and Oyster Point. In any event, the dredging required would be relatively minor -- generally less than 50,000 cubic yards (0.050 mcy) each.

Larger amounts of dredging may be required to provide good ferry access to Benicia, the San Francisco Airport, and the Oakland Airport. Investigations will need to be performed to determine whether toxics are present in dredge materials near the airports. Although the quantities could vary greatly depending on the location of the terminal, none of these are likely to be major dredging projects. The amounts of dredging required for each could range greatly, for example, from 25,000 to 250,000 cubic yards (0.025 to 0.250 mcy). As an alternative to dredging where shallow water depths are present, consideration should be given to the use of hovercraft, a viable ferry mode which would create other impacts such as noise.

An order-of-magnitude range of the estimated dredging required for these seven terminals, and hence, for this Alternative would be between 150,000 and 500,000 cubic yards (0.150 to .500

mcy). This would be less than one-tenth the average annual quantities dredged in the Bay in 1986-87.

Alternative 4: Interstate 380 to 238

Most of the length of the bridge in this alternative would be supported on driven piles for which no dredging would be required. The high-rise section over the ship channel would be built on piers approximately 500 feet apart. The piers would be supported in sunken caissons; each caisson would require the removal of an estimated 1,200 cubic yards of Bay Mud.[1] Since there would be about 20 caissons, the total amount of dredging required for this alternative is not estimated to exceed 24,000 cubic yards (0.024 mcy).

Alternative 6: BART Airport Connection

It is estimated that approximately 11 miles of the 21.6 mile length of this Alternative would be installed in a dredged trench beneath the Bay. Bay Mud would be dredged, probably with a siphon dredge, to create the trench. If not sufficiently consolidated, the bottom of the trench would be prepared with imported fill, then the tube sections would be installed and finally they would be backfilled with a cover of imported fill and rock to protect the upper surface. Engineers estimate that this Alternative would require as much as 11.8 mcy of dredging, spread over a one to two year period.[2] This would be almost equivalent to the annual average for all dredging activity in the Bay in 1986 and 1987.

Alternative 8: BART Transbay Tube

This Alternative would be constructed in the same manner as Alternative 6. The length of the alignment that would require a dredged trench is about 3.5 miles, as compared to about 10.4 miles for the BART Airport Connection. It is estimated, therefore, that this Alternative would generate the need for approximately 3.9 mcy of dredging activity over a one to two year period.

---

[1] Thomas Jee, Sverdrup Corporation, personal communication, September 17, 1990.

[2] Based on an estimate of 204 cubic yards of dredging per lineal foot of submerged BART tube. Thomas Jee, Sverdrup Corporation, personal communication. August 18, 1990.

Alternative 11: Inter-City Railroad Tunnel

Alternative 11 would be constructed in a manner similar to Alternatives 6 and 8, but the tunnel would be taller requiring a deeper dredged trench.[1] The 4.2-mile underwater length of Alternative 11 is estimated to require approximately 6.1 mcy of dredging. This approaches the annual average amount dredged in the Bay in 1986 and 1987, or half the annual average if the work were spread over two years.

In addition, this alternative would appear to have a higher chance than the others of being affected by special requirements for the disposal of contaminated dredge spoils. Its alignment passes north of China Basin and Islais Creek in San Francisco and through the Oakland Harbor. Both areas have been in industrial use for over 100 years, and are known to have higher than average levels of heavy metals (e.g., lead, mercury, silver) and some organic contaminants in the sediments.[2]

Noise and Vibration

Introduction and Setting

Many types of urban mass transportation projects have the potential to increase noise and vibration levels in a community: sources of noise can include vehicle operating noise, noise from fixed transit facilities such as ventilators or guideway structure vibrations, and noise caused by diversions or increases in local traffic due to a transit improvement or new freeway facility. Ground vibrations from passing rail vehicles or heavy trucks can also be felt at locations adjacent to the transit facility.

The determination of noise and vibration impacts is not simply a function of the absolute noise levels generated by a transit facility. The potential for noise impacts is also governed by the sensitivity of surrounding land uses to increased noise and by the presence or absence of

---

[1] Engineers estimate that this alternative would require approximately 279 cubic yards of dredging per lineal foot of tunnel. Thomas Jee, Sverdrup Corporation, personal communication, August 18, 1990.

[2] San Francisco Estuary Project, op. cit., pp. 110-113, 121, 129.

existing noise sources. Land uses with the highest sensitivity to noise include residences in quiet neighborhoods and parks set aside as places of quiet and serenity. Somewhat less sensitive uses would include higher density residential buildings and other buildings, such as motels, where nighttime quiet is important for sleeping. Institutional land uses with primarily daytime occupancy -- schools, churches, libraries, active parks -- are also noise sensitive, but less so than places with sleeping quarters.[1]

Noise and vibration impacts of specific projects are determined through a process of monitoring existing noise levels in accordance with one or more specific noise descriptors appropriate for the source and the community. Applicable impact criteria are then selected. In some cases they will be specified by funding agencies, such as the Department of Transportation, or local communities.[2] Relative noise impacts are then projected by combining the calculated levels of future project noise with the existing noise levels and comparing the result with applicable impact criteria. If the applicable criteria will be exceeded, mitigation must be specified and incorporated into the project design. Generally mitigation can be successfully applied at the source of the noise, along the path of the noise, or, occasionally, at the receiver. Requirements for noise reduction in the manufacture of cars and trucks and the construction of noise barriers along freeways, expressways, and arterials are the most common type of noise mitigation seen today. BART has also erected 3½ to 5 foot high barriers at many locations along its guideways adjacent to sensitive receptors.

Detailed noise impact and mitigation reports will be required in the planning of any of the bay crossing alternatives selected for implementation. The purpose of this section therefore, will be to identify the potential for each Alternative to create noise impacts which would, in turn, require significant mitigation.

---

[1] Based on Urban Mass Transportation Administration Noise Impact Categories; UMTA, *Procedures and Technical Methods for Transit Project Planning*, Review Draft, September 1986, Part II, p. 7-25.

[2] Each city in California must have a Noise Element in its General Plan. These frequently specify acceptable noise descriptors, impact levels, and identify sensitive receptors.

Issues Raised by the Five Alternatives

Alternative 1: High-Speed Ferry

The operation of the ferry boats is generally quiet. Extensive muffling of the exhaust and isolation of the engines to reduce the on-board noise levels is very effective in attenuating the boats' environmental noise. Monitoring recently conducted in conjunction with the Bay Farm Island Ferry[1] test runs found that the ferry noise did not exceed 63 dBA[2] at the nearest residences and was barely audible as a component of the background noise. Maximum noise levels adjacent to the wharf was 73 dBA, well below the levels of aircraft departing Oakland Airport.[3] If a hovercraft is to be considered as an alternative in shallow water depths then mitigations must be developed to offset potential noise impacts.

All of the potential ferry terminal sites are located adjacent to areas of commercial or industrial development and/or zoning. It is not expected that any of them would be adjacent to sensitive receptors. Even if they were, it is likely that site-specific noise studies would not find significant impacts considering the expected low maximum noise levels, the limited amount of maneuvering time beside each dock and the limited number of nighttime operations.

Alternative 4: Interstate 380 to 238 Bridge Connection

This Alternative would construct a major new freeway and BART link between the West Bay and East Bay. In the West Bay it would pass through industrial areas north of San Francisco International Airport, where sensitive noise receptors are not likely to be found. In the East Bay, this Alternative would pass through extensive single-family residential developments in the vicinity of San Leandro/San Lorenzo. Significant noise impacts could be expected and a major mitigation program is likely to be required.

---

[1] The boat tested was a 90-foot, mono-hulled passenger ferry with diesel engines totaling 2,600 horsepower.

[2] dBA is a measure of sound in the units of decibels (dB). The "A" denotes the A-weighted scale, which simulates the response of the human ear to various frequencies of sound.

[3] LSA Associates, *Biological Report, Harbor Bay Ferry Terminal*, January, 1990, p. 4 and Appendix A.

In the East Bay, the bridge alignment would be clear of the approach slope to the Oakland Airport; however, concern has been raised by San Leandro that jet aircraft passing 200-300 feet overhead would be distracting to motorists on the bridge.

Alternative 6: BART Airport Connection

Alternative 6 would follow the Southern Pacific right-of-way west of the San Francisco International Airport passing alongside and through several residential subdivisions. Similarly, in the East Bay, this Alternative would pass through several established residential neighborhoods in San Leandro as it curves south to connect with the Fremont BART line. Development of this Alternative would require detailed noise studies. Impacts can be expected and mitigation will be necessary.

Alternative 8: Transbay Tube

This Alternative would be underground in San Francisco and for most of its length in Oakland. The portion of elevated structure in Oakland would be located in an industrial area with few, if any, sensitive receptors. It is possible, however, that a few non-conforming residential buildings are located in the industrial zone along the proposed alignment. If so, they could be impacted and mitigation may be necessary.

Alternative 11: Inter-City Railroad Tunnel

Alternative 11 would be sub-surface in San Francisco and at-grade or elevated in the Port of Oakland. Land uses along the alignment are devoted to industrial and commercial uses. It is not likely that any sensitive receptors are located along this route.

Air Quality

Introduction and Setting

The Federal and State Clean Air Acts establish air quality standards to protect the public health and welfare. Specific standards have been established for several criteria pollutants and air quality is monitored on an ongoing basis by the Bay Area Air Quality Management District at monitoring stations located throughout the region. The region has not attained the applicable standards for several important pollutants.

Motor vehicles are the largest source of carbon monoxide emissions and a major source of oxides of nitrogen and hydrocarbons in the Bay Area. Carbon Monoxide (CO) is a highly toxic, odorless, colorless gas that replaces oxygen in the blood, causing severe heart and lung problems and impaired mental functioning at high concentrations. Its potential dangers are concentrated, therefore, in localized areas experiencing heavy traffic congestion.

Oxides of Nitrogen (NOx) and Hydrocarbons (HC), mixed in the presence of sunshine, combine in complex chemical reactions to form Ozone, a pollutant that damages lung tissues, irritates eyes, and can have other adverse health effects. Ozone is considered a pollutant of regional significance.

Despite considerable improvement in air quality (and declining vehicle emissions due to improved emission controls mandated by the Clean Air Acts), the Bay Area did not meet the 1987 deadline for the attainment of the Federal Air Quality Standards. In 1990, the Federal Standard for Ozone was exceeded on only two days for a total of six hours; the more stringent State Ozone Standard was exceeded on 14 days.

The increasing population and economic activity in the region is projected to lead to significant increases in regional vehicle miles traveled over the coming years. This will partially offset the reductions obtained from cleaner engines, and additional steps will be necessary in order to attain and maintain the air quality standards established in the Clean Air Acts. Consequently, transportation projects are being carefully reviewed for potential significant adverse air quality impacts. For Carbon Monoxide, MTC is requiring projections of one-hour and eight-hour CO concentrations adjacent to intersections, freeways or other areas of concentrated vehicular

activity. If exceedances of the state or federal standards are projected, mitigation may be required and/or the project may not be eligible for State or Federal funding.

Projects must also be reviewed for HC emissions. If the HC emissions are projected to be greater with the project ("build" conditions) than without ("no-build" conditions), the project will also be considered detrimental to air quality and will not be considered for state or federal funding.[1]

<u>Impacts</u>

Carbon Monoxide

All of the Alternatives have some potential to create exceedances of the CO Standards at localized intersections, access ramps, or other congestion points. With Alternative 1, the Ferry Alternative, short-term congestion could be created along local streets or at parking lot exits. If severe congestion were created at key intersections, the CO impacts could be significant. Impacts could be avoided with careful planning of terminal access and the provision of adequate traffic capacity on local streets serving the terminals.

Alternative 4, the I-380 to I-238 Bridge, has the potential to create localized congestion points at the bridge approaches in both the East and West Bay. It is expected that most of the impacts could be mitigated with adequate design of the approach roads and mitigation at impacted local intersections. However, the congestion on US 101 north of I-380 that would occur with this Alternative would be significant and the mitigating freeway improvements might not be practicable due to the cost and other factors. This Alternative is judged to have a moderate to high potential for unmitigable CO impacts.

Alternatives 6, 8, and 11 all have relatively low potential for CO impacts. Like the ferry system, the only potential for impact would occur at station access points. Although they would utilize existing stations for the most part, mitigation may be necessary at specific intersections to reduce

---

[1] Metropolitan Transportation Commission, *Criteria for Determining the Air Quality Impacts of Highway Projects*, Attachment A, Resolution 2107, Revised 12/20/89, pp. 5-6.

increased congestion from the greater ridership. Access to the new station at the Oakland Airport would have to be carefully planned to avoid localized CO exceedances.

Hydrocarbons

Using the travel forecasting data prepared by MTC, the potential Hydrocarbon emissions for the Alternatives in 2010 were estimated relative to the Regional Transportation Plan "Blend" Alternative. They are summarized below in Table 5-1:

TABLE 5-1
PROJECTED HYDROCARBON EMISSIONS, YEAR 2010
Tons/day

RTP Blend Alternative	Alt.1 Ferries BART	Alt. 4 Bridge/ BART	Alt. 6 Airport BART Tube	Alt. 8 Additional Tunnel	Alt. 11 Railroad
65.30	65.13	65.13	65.23	65.28	65.22

The projected emissions among all of the Alternatives are very close; there are essentially no significant benefits or detriments in hydrocarbon emissions attributable to any Alternative. It is noteworthy, however, that all of the bay crossing alternatives have slightly lower projected HC emissions than the RTP Blend Alternative. This can be attributed to the increased transit ridership with all the Alternatives and a reduction in the regional average trip length due to the new Bridge in Alternative 4.

In conclusion, the Air Quality impacts of all the Alternatives are judged to be low, assuming that any localized CO "hotspots" that might be created could be mitigated during project design. Based on the MTC evaluation criteria, the Alternatives would be classified as Low or perhaps, "Neutral" since the projected benefits are comparatively small, and fall well within the margin of error of the projection methodology.

Figure 5-1

SUMMARY OF IMPACTS

5.3 SOCIO-ECONOMIC CONSIDERATIONS

Consistency with General Plans and Zoning Policies

Introduction and Background

This section of the alternatives evaluation will examine regional and local plans that govern land use activities in the communities affected by the five bay crossing alternatives. The discussion below is organized in two parts, the first being a discussion of regional plans which could effect all of the alternatives. Local Plans and Policies that are applicable to specific alternatives are categorized by alternative. Relevant planning policies are cited verbatim or summarized with a discussion of compatibility of the appropriate alternative immediately following. This section also addresses the cultural and historic resources identified in local general plans and the potential for impacts upon known resources.

It is recognized that there are numerous regional and local plans that have policies which could affect the bay crossing alternatives. A comprehensive analysis of all known plans is beyond the scope or the purpose of this assessment. For purposes of this analysis the following plans are discussed to present a generalized overview of policies that are pertinent to a future new crossing of the Bay.

- Regional Plans
  San Francisco Bay Plan
  San Francisco Bay Area Seaport Plan
  Regional Transportation Plan
  Regional Plan 1980 -- San Francisco Bay Area
  Bay Trail Plan

- Local General Plans
  - San Leandro General Plan
  - Alameda County General Plan: Eden Plan (includes San Lorenzo)
  - San Francisco International Airport Final Draft Master Plan
  - Metropolitan Oakland International Airport Master Plan Update
  - Oakland Comprehensive Plan
  - San Francisco Downtown Plan
  - Mission Bay Plan
  - South San Francisco General Plan

<u>Regional Plans</u>

1) San Francisco Bay Plan, January 1969, as amended July 1988

The San Francisco Bay Conservation and Development Commission (BCDC) was directed by the McAteer-Petris Act of 1965 to prepare an enforceable plan to guide the future protection and use of San Francisco Bay and its shoreline. Its charge was expanded in 1969 to extend BCDC's authority as the agency responsible for maintaining and carrying out the Act and the Bay Plan, including the regulatory authority to issue or deny permit applications for bay filling and dredging and shoreline development. Major Plan Policies and Proposals with relevance to the analysis of bay crossing alternatives are summarized below and compliance of the proposed alternatives are discussed after each policy or proposal.

- Major Conclusions and Policies[1]

#1: "Uses of the Shoreline. All desirable, high-priority uses of the Bay and shoreline can be fully accommodated without substantial bay filling, and without loss of large natural resource areas. But shoreline areas suitable for priority uses -- ports, water-related industry, airports, wildlife refuges, and water-related recreation -- exist only in limited amount, and should be reserved for these purposes."

---

[1] Major conclusions and policies that are applicable to the proposed project are quoted verbatim from the San Francisco Bay Plan Summary, pp. 1-3.

Alternative 1, High-Speed Ferry Service would implement this policy regarding priority uses since facilities could be located at existing port facilities (e.g., San Francisco, Redwood City) or in marinas. Ferry service would enhance surface mobility between ports. Although construction of expanded or new facilities would be required, such facilities could be accomplished without substantial bay filling, although dredging would be required at some of the 17 locations to achieve sufficient water depth. Alternative 4, 380 to 238 Bridge, would require fill since the bridge pilings are considered to be "fill", breaking the surface of the Bay. Shoreline impacts on wildlife and recreation would also occur. Alternatives 6, 8, and 11 would require a dredged trench lined with imported fill (gravel and rock material) and additional backfill after the tube sections are installed. While Alternatives 6, 8, and 11 would have significant impacts in the Bay, landward activities would have a negligible effect on shoreline priority uses. Most of the transition structures would reach the surface landward of BCDC's area of jurisdiction.

#4: "Justifiable Filling. Some bay filling may be justified for purposes providing substantial public benefits if these same benefits could not be achieved equally well without filling. Substantial public benefits are provided by:

(e) Developing new freeway routes (with construction on pilings, not solid fill) <u>if</u> thorough study determines that no feasible alternatives are available."

Alternative 4 would construct a new freeway bridge across the Bay. The proposed construction methodology would minimize filling as most of the length of the bridge (the trestle portion) would be supported on driven piles for which no dredging is required. The high-rise section of the bridge would be supported with sunken caissons, which would require some fill. Any filling of the Bay requires a permit from BCDC. BCDC is guided by Government Code Section 66632(a) in making a determination regarding fill. Section 66632(a) defines fill as any material put into the Bay, a pile-supported structure over the Bay, or a structure floating on the waters of the Bay. Alternatives 6, 8, and 11 involve a tube or tunnel, which, as discussed in previous sections of this report, would require significant amounts of material to create a bed for the tube/tunnel sections and to bayfill over the tube once it is in place. Determining whether this would be "justifiable filling" based on achieving "substantial public benefit" is not within the scope of this study.

- Major Plan Proposals[1]

#1: "Develop Maritime Ports. Port expansion and development should be planned for Alameda, Benicia, Oakland, Redwood City, Richmond, San Francisco and Selby."

Alternative 1 would enhance port expansion and development by providing ferry service in Benicia, Redwood City, Richmond, and San Francisco. Alternatives 4 and 6 are not near any of the identified ports. Alternatives 8, Transbay Tube, and 11, Inter-City Railroad Tunnel, would be constructed through the Port of Oakland. Construction activities would be disruptive to port activities; however, operational impacts would not significantly effect existing land use at the Port of Oakland. Alternative 11 would facilitate goods movement between the Port of San Francisco and the Port of Oakland.

#6: "Maintain Wildlife Areas in Diked Historic Baylands. Prime wildlife refuges in diked-off areas around the Bay should be maintained and several major additions should be made to the existing refuge system."

Of the 280 square miles of the Bay's surface area that has been diked from tidal action since the 1880s, all but about 80 acres, excluding salt ponds and managed wetlands, have been filled. Many of the unfilled areas behind dikes provide high value wildlife habitat. Frequently, these areas are not within BCDC's permit jurisdiction although they may require Section 404 permits from the Corps of Engineers to fill.

The development of Alternatives 1, 4, and 6 have the potential to affect some diked historic wetland areas that are unfilled and may have high wildlife value. The potential impacts on wetlands are addressed in greater detail in Section 5.2, above. While it is not likely that any of the ferry terminals (Alternative #1) would themselves require the conversion of wetland habitats, the need to provide parking and access roads could affect nearby wetlands at some ferry sites. Alternative 4 could affect wetland areas in the West Bay near the I-380 connection and in San Leandro near the Estudillo Canal. Similarly, Alternative 6 could affect wetlands where it is above ground in the vicinity of both the San Francisco and Oakland Airports.

---

[1] Ibid.

- Specific Bay Plan Policies

In addition to the general policies and proposals discussed above, the San Francisco Bay Plan includes specific policies on issues such as dredging, ports, transportation, appearance, design, and scenic views that have particular relevance to one or more of the bay crossing alternatives evaluated in this report. Those specific policies include:

Dredging[1]
Policy #1: "To prevent sedimentation resulting from dredging projects, mud from future dredging should be disposed of in one of the following ways: (a) placement on dry land; (b) placement as fill in approved fill projects; (c) barging or piping to suitable disposal sites in the ocean..."

As discussed in Section 2.3, Dredging and Water Quality, all of the tube or tunnel alternatives (6, 8, and 11) would require dredging, in addition to the ports or marinas described in Alternative 1 that have inadequate water depth to accommodate ferry service. The technique proposed for Alternatives 6, 8, and 11 would be to dredge a trench beneath the Bay, using a high pressure siphon dredge to bring the materials through a tube to a surface barge that would haul the dredge materials to a suitable disposal site. This dredging method may or may not be in compliance with "c" in the dredging policy described above, depending upon where the dredge spoils are deposited. BCDC may require upland or ocean disposal to conform with this policy.

Ports[2]
Policy #1: "Port planning and development should be governed by the policies of the Seaport Plan and the applicable policies of the Bay Plan. The Seaport Plan provides for:

a. Expansion and/or redevelopment of port facilities at Alameda, Benicia, Oakland, Redwood City, Richmond, San Francisco and Selby."

Alternative 1, High-Speed Ferry System, proposes improvements to port facilities at Redwood City, Richmond, and San Francisco. Improvements included for the ports include docking facilities, terminal facilities, parking facilities, intermodal transfer facilities to interface with other

---

[1] Bay Plan, op. cit., p. 15.

[2] Bay Plan, op. cit., p. 18.

mass transit feeder systems, access roads, and a long-span loading pier for areas with shallow water depths. Alternative 1 is in compliance with the above policy.

Transportation[1]

Policy #1: "The Bay represents a great but, at present, little-used resource for transportation within the region...Also, a system of modern ferries (capable of high speeds with minimum noise and waves) may be able to provide service between major traffic generators (e.g., between downtowns, or between downtowns and airports) and eventually to provide scheduled service from one end of the Bay to the other for both commuting and pleasure use."

Alternative 1 would implement this Bay Plan policy providing ferry service in 17 locations from Benicia and Martinez in Suisun Bay to Redwood City in the southern reaches of San Francisco Bay. Major traffic generators such as downtown employment centers and airports would be connected by ferry service. The routes chosen for this alternative were selected based on current travel patterns and the location of currently overburdened transportation facilities, as well as the viability of individual ferry terminal locations. Non-stop service would be provided during commute hours, with multiple stops on routes during off-peak hours to accommodate both commuting and pleasure use. Catamaran type vessels with 400 passenger capacity and 30 knot speed are proposed for all routes.

On October 5, 1989, the San Francisco Bay Conservation and Development Commission amended the Transportation section (page 25) of the San Francisco Bay Plan as indicated below.[2] Policies were changed to read as follows:

"Because of the continuing vulnerability of the Bay to filling for roads, the Commission should continue to take an active role in Bay Area transportation planning affecting the Bay, particularly to encourage alternative methods of transportation to be used within the Bay Area that do not require fill. The Metropolitan Transportation Commission, the California Department of Transportation, the California Transportation Commission, the Federal Highway Administration,

---

[1] Bay Plan, op. cit., p. 25.

[2] San Francisco Bay Conservation and Development Commission, memorandum to All Commissioners, Alternates and Interested Parties, from Alan R. Pendleton, Executive Director, re: Bay Plan Amendment No. 2-89 Concerning Transportation, December 12, 1989.

and other public and private transportation authorities should avoid planning or funding roads that would require fill in waterways."

"If any additional bridge is proposed across the Bay, adequate research and testing should determine whether an alternative could overcome the particular congestion problem without such a route in the Bay and, if not, whether a tunnel beneath the Bay is at all feasible."

"If a route must be located across a waterway, the following provisions should apply:

a. The crossing should be placed on a bridge or in a tunnel, not on solid fill.

b. Structures should provide adequate clearance for commercial ships, Navy ships, and pleasure boats to have uninterrupted passage at all times.

c. Toll plazas, service yards, other ancillary features should not be located on new fill.

d. To provide maximum ultimate capacity on any new route that is allowed over or under a waterway (and thus to minimize the number that might have to be allowed in the Bay), the design of the route should, if feasible, accommodate future mass transit facilities and subsequent installation of automatic power and guidance elements for vehicles."

The San Francisco Bay Crossing Study is the first step in examining the feasibility of a new crossing of the Bay. The study examines one bridge and four tunnel alternatives, all of which include a BART component. None of the alternatives being examined include solid filling of the Bay for future roadways. All of the alternatives comply with policies a, b, c, and d above.

Appearance, Design and Scenic Views[1]

Policy #4: "Structures and facilities that do not take advantage of or visually complement the Bay should be located and designed so as not to impact visually on the Bay and shoreline. In particular, parking areas should be located away from the shoreline."

---

[1] Bay Plan, op. cit., p. 29.

Parking lots or structures are proposed for each of the ferry terminal locations in Alternative 1. To mitigate the potentially negative visual impact, such facilities should be set back from the shoreline and landscaped with native and drought-resistent plant materials.

Policy #6: "Additional bridges over the Bay should be avoided, to the extent possible, to preserve the visual impact of the large expanse of the Bay. The design of new crossings deemed necessary should relate to others nearby and should be located between promontories or other land forms that naturally suggest themselves as connections reaching across the Bay (but without destroying the obvious character of the promontory). New or remodeled bridges across the Bay should be designed to permit maximum viewing of the Bay and its surroundings by both motorist and pedestrians. Guard rails and bridge supports should be designed with views in mind."

Avoiding an additional bridge over the Bay would be accomplished by Alternatives 1, 6, 8, and 11. Alternative 4, Interstate 380 to 238 Bridge Connection, would result in a bridge of orthotropic design, similar to the San Mateo-Hayward Bridge, which permits views of the Bay and surrounding areas. Per BCDC policy, the bridge would include bicycle and pedestrian access. It is noted that the bridge alternative would not be in compliance with the first portion of Policy #6, which is to avoid additional bridges over the Bay.

Policy #7: "Access routes to bay crossings should be designed so as to orient the traveler to the Bay (as in the main approaches to the Golden Gate Bridge)."

The topography on the main approaches to the bridge in Alternative 4 is flat which would preclude the dramatic approach to the bridge found with the Golden Gate. However, approaches to the eastern and western trestle span would be elevated to a height of 15 feet, providing improved vistas of the Bay.

2) San Francisco Bay Area Seaport Plan, 1982, Revised 1988

The Seaport Plan for the San Francisco Bay Area was prepared through a cooperative effort of the Metropolitan Transportation Commission and BCDC. The Plan responds to requirements for a maritime element to MTC's Regional Transportation Plan and as a regional port development plan for BCDC's San Francisco Bay Plan. It is important to note that the Maritime Element of

MTC's Regional Transportation Plan states that the Seaport Plan "shall guide MTC in its decisions on seaport development and related proposals for transportation and land use development."[1]

The Seaport Plan has four goals:

1. Ensure the continuation of the San Francisco Bay Port system as a major world port and contributor to the economic vitality of the San Francisco Bay Region.

2. Maintain or improve the environmental quality of San Francisco Bay and its environs.

3. Provide for the efficient use of finite physical and fiscal resources consumed in developing and operating marine terminals.

4. Provide for integrated and improved surface transportation facilities between San Francisco Bay Ports and terminals and other regional transportation systems.

The Plan focuses on the six major publicly-used ports in the Bay Area: Benicia, Oakland, Redwood City, Richmond, San Francisco, Encinal Terminals in Alameda, and Vallejo. The Seaport Plan identifies "port priority use areas" to protect these ports for marine terminals and directly-related ancillary activities.[2]

Alternative 1 would complement the goals of the Seaport Plan, in particular, Goal #4, since ferry service would be provided for improved movement of goods between bay ports.

---

[1] The San Francisco Bay Area Seaport Plan, 1982, Revised 1988, p. 1.

[2] The Plan defines port priority use areas in Finding r, page 16, as follows: Port priority use areas include within their premises marine terminals and directly-related ancillary activities such as container freight stations, transit sheds and other temporary storage, ship repairing, support transportation uses including trucking and railroad yards, freight forwarders, government offices related to the port activity, chandlers and marine services. Other uses, especially public access and public and commercial recreational development, are permissible uses provided they do not significantly impair the efficient utilization of the port area.

3) Regional Transportation Plan[1]

The Metropolitan Transportation Commission (MTC) was created by the California State Legislature, in 1970, to prepare a Regional Transportation Plan (RTP) for the nine counties of the San Francisco Bay Area. The 1970 legislation also directed MTC to revise the RTP annually. Further, the RTP is the transportation element for the Regional Plan prepared by ABAG. (See following discussion in 4. Regional Plan 1980.)

Among the policies of the RTP that have particular relevance to the study of potential crossings of the Bay, are the following: Policy 2.2 states that "Transportation facilities shall avoid the destruction of irreplaceable resources such as the Bay and its shoreline, the coast, important open space lands, recreational areas, historical sites, and prime agricultural areas, unless there is no feasible alternative--in which case all feasible measures to mitigate the effect shall be implemented." Additionally, policy 2.5 states that "Priority shall be given to projects or programs that reduce dependence on automobile travel and conserve energy, including projects that enhance or complement pedestrian, bicycle, car/van pool, and transit travel."[2]

Policy 4.1 adds that "Transportation projects shall be approved only when they fulfill a demonstrated need, and have a reasonable relationship of costs to the expected benefits." Port facilities are discussed in the Seaport Plan, above, and the relevant policy regarding airports is included in Policy 5.10 "Ground transportation facilities and services shall be planned and programmed to reinforce the role of each airport in the regional plan. The long-range goal of transportation development programs at all airports shall be to serve a minimum of 25 percent of the air passenger and airport employees by transit." [3]

---

[1] Regional Transportation Plan for the San Francisco Bay Area, Metropolitan Transportation Commission, October 1988.

[2] Regional Transportation Plan, Op. cit., p. 2.

[3] Regional Transportation Plan, Op. cit., pp. 4-6.

4) Regional Plan 1980 -- San Francisco Bay Area[1]

In 1961, local governments founded the Association of Bay Area Governments (ABAG) to plan for the physical, social and economic well being of the nine county Bay Area. The 1980 Regional Plan is an update of the original 1970 Regional Plan. The regional planning program includes goals, objectives and policies, regional strategies and subregional planning. A key component of the Regional Plan, and a theme that is reiterated throughout the document, is summarized in Goal #1: "Regional and subregional growth consistent with the city-centered concept of regional development." This long-range planning goal is further reinforced by Goal #12 calling for "A transportation system that is integrated with the city-centered concept of regional development."[2]

The Regional Strategies section of the Plan links the city-centered emphasis to transportation in Regional Strategy #3: "Living, working and shopping with the same community should be planned and promoted by all level of government and the private sector....The need for long commuting should be reduced." To implement this strategy, ABAG, in reviewing plans and projects, will look for provisions which "provide decreased reliance on the automobile as the basic transportation mode for daily life rather than alternative means of travel, particularly public transit...."[3]

Each of the alternatives studied in this report have a public transit component ranging from ferry service to BART and trains. Alternative 4 also includes a bridge, permitting single-occupancy vehicles as well as HOVs and BART, which would be less effective than the other alternatives in decreasing reliance on the automobile.

---

[1] Regional Plan 1980: San Francisco Bay Area, Association of Bay Area Governments, 1980.

[2] Regional Plan 1980: San Francisco Bay Area, Op. cit., p. Goals-1.

[3] Regional Plan 1980: San Francisco Bay Area, Op. cit., p. 3.

5) Bay Trail Plan (ABAG, 1989)

The Bay Trail Plan establishes policies and a proposed alignment for a roughly 550-mile long bicycle and pedestrian trail system around the perimeter of San Francisco and San Pablo Bay. Alternate 4 would cross the trail both in the West and East Bay. While the elevated approaches to the bridge would provide for grade separation at these points, there would be visual and noise impacts at these locations. However, pedestrian and bide connections with handicapped access could allow the new bridge to provide a new link in the trail system.

<u>Local Plans</u>

1) Alternative 4: Interstate 380 to 238 Bridge Connection

- San Leandro General Plan and Zoning

The San Leandro General Plan was adopted March 20, 1989. The Land Use Element of the General Plan identifies areas of change during the next 15 years. The alignment followed by Alternative 4 is depicted as an area of "no change" between I-238 on the east and the flood control canal on the west. South of the flood control and west of Wicks Boulevard up to the Tony Lema Golf Course, the area is designated as "major change". The General Plan identifies six "Key Issues for the Future" that could be significantly impacted by implementation of Alternative 4. The first priority "key issue" is neighborhood and land use integrity which involves protection and preservation of established neighborhoods. Policies relating to this issue include preventing land use conflicts, minimizing or keeping out traffic, noise, or other nuisances. Construction of Alternative 4 along the Manor Boulevard alignment would directly conflict with this highest priority issue and supporting General Plan policies.

Zoning for the East Bay segment of Alternative 4 is varied. The area surrounding the I-880/I-238 interchange is zoned for a Planned Development Combining (PDC) with and underlying zoning of N (Nursery), requiring Planning Commission approval for projects proposed within the combining district. West of I-880 to just east of Wicks Boulevard, Manor Boulevard is zoned commercial (C-2 Light Commercial, C-4 General Commercial) and residential (R-1 Single-Family, R-2 Two-Family). Moving west of Wicks Boulevard, north of the canal, existing zoning designations are I-P (Industrial Park), R-1 PDC (Single-Family/Planning Development Combining)

and C-R (Commercial Recreation) for the Tony Lema Golf Course. The dredge material storage area south of the canal and west of the Southern Pacific Railroad is zoned I-2 (General Industrial).

The General Plan Land Use Element designation for Alternative Alignment 4A is for "No Change" in the area around the freeway interchange, "trend change" for the area surrounding the intersection of Washington Boulevard and Lewelling Boulevard, "no change" through the single-family residential neighborhoods, and "major change" west of the SPRR line and just east of the shoreline. The shoreline area is indicated as "no change".

The zoning for Alternative Alignment 4A is the same as Alternative 4 for the area surrounding the I-880/I-238 Interchange, N (Nursery) zoning with a PDC (Planned Development Combining) overlay. West of Washington Boulevard the alignment passes through an area that is variously zoned C-2, Light Commercial, R-5 Multiple Residence, R-3 Multiple Residence and R-1 Single-Family Residence. West of approximately Sedgeman Street, the alignment continues over the San Lorenzo Creek channel. Zoning in the area on the north side of the creek, in the City of San Leandro, is R-1 single-family residence. West of the SPRR line, the alignment remains totally within San Leandro and is zoned I-2 General Industrial and C-R Commercial Recreation along the shoreline.

Historic and Cultural Resources

The General Plan identifies 33 major historic and cultural resources in the City of San Leandro. Most of the identified resources are clustered in the northeastern portion of the city. None of the sites would be directly impacted by the alignment for Alternative 4; however site #17, San Leandro Oyster Beds Site, California Landmark No. 824 (1890), is located immediately to the north, within the San Leandro Marina.

Alternative alignment 4A would pass near two identified sites, #13, Captain Roberts Home (1875) and #4, Roberts' Landing Site (1850).

- Alameda County General Plan: Eden Plan

The unincorporated community of San Lorenzo is under the planning jurisdiction of Alameda County. The County General Plan contains a series of area plans which group several

communities together for the purposes of long-range planning. The Eden Plan, adopted in 1983, includes San Lorenzo. The alignment for Alternative 4A is bounded by San Leandro on the north and San Lorenzo on the south for the portion between the area immediately north of Arroyo High School, west to the SPRR line. The Eden Plan designates this area for Suburban/Low Density residential use, with a corresponding zoning designation of R-1 Single-Family Residence.

- South San Francisco General Plan and Zoning

The City of South San Francisco "Land Use, Circulation and Transportation Elements of the General Plan" was amended and approved in June 1986. The Land Use Element divides the city into ten Planning Areas and discusses land uses within each. Alternative 4 passes through Planning Area #1 (South Airport Area) for lands east of the Bayshore Freeway, and Planning Area #7 (Lindenville) addressing lands west of the Bayshore.

The BART alignment for Alternative 4, heading west from the Bay, passes first through an area designated Planned Industrial land use then continues through the lands fronting on South Airport Boulevard which are designated for Planned Commercial use. West of the Bayshore Freeway the alignment enters the Lindenville Planning Area where the land use designation is Light Industrial and Planned Industrial.

The roadway alignment is located wholly within the Southern Sub-Area of the South Airport Planning Area where the land use designation is for Planning Industrial land use.

Zoning designations for the Alternative 4 alignment correspond to M-1 for areas designated Light Industrial, P-1 for Planned Industrial use, and P-C for Planned Commercial areas.

Historic and Cultural Resources

The Land Use Element of the General Plan does not specifically identify cultural or historic resources or sites. Historical Preservation Policy 28 of the General Plan Land Use Element states that "The City should require property owners to preserve, relocate and/or restore those buildings which have been identified as having historic, cultural or architectural value."

2) Alternative 6: BART Airport Connection

- San Francisco Airport Master Plan

The San Francisco International Airport Final Draft Master Plan was published in November 1989. The Master Plan is divided into two phases: a near-term Master Plan for improvements to be implemented in 1990-1996 and a long-term Master Plan through the Year 2006. The near-term

Master Plan proposes an automated peoplemover system to connect a proposed centralized ground transportation center to the terminal areas. The peoplemover system will consist of a dual fixed-guideway alignment with trains moving in both directions. The long-term Master Plan would expand the peoplemover system, including a northern terminus at the United Airlines maintenance facilities.

The West Bay segment of Alternative 6 calls for BART to remain in a subway facility moving west from the Bay and transitioning to an elevated structure west of Highway 101. The line would turn north to meet with the BART SFO Extension station, west of the airport. This alternative envisions extending the airport's peoplemover from the United Airlines maintenance facility to connect with the BART station. This would not result in a conflict with the Airport Master Plan and would provide a reasonable connection, via the peoplemover, between the BART station and the airport terminal facilities and employment activities.

- Oakland Airport Master Plan

The Port of Oakland is currently in the process of updating the Master Plan for the Airport. The planning process is being divided into two ten-year phases. The first ten-year phase of the plan addresses the "Passenger Terminal Facilities Expansion Program". This program involves only terminal and parking facility improvements and does not include runway alternatives or undeveloped airport lands. A terminal development plan alternative has been selected and will be the subject of a Draft EIR, which is anticipated to be published for public review and comment in December, 1990 or January, 1991.

The second phase of the Airport Master Plan involves new runways and other facilities and will require the preparation of an Environmental Impact Report/Environmental Impact Statement (EIR/EIS) since the Federal Aviation Administration shares the Lead Agency Role. The second phase plan and environmental documentation is expected to start at the end of this year and take two to three years to complete the EIR/EIS and plan approvals.

As part of the Metropolitan Oakland International Airport Master Plan Update, the Port published "Chapter 7: Alternative Evaluation" in July, 1990. This document describes the selected terminal development plan that will be evaluated in the EIR. The selected plan includes a central parking structure to be constructed over the existing surface parking lot, a central station for future

connection to BART, and a reconfiguration of the terminal drive with horizontal separation of arrival and departure vehicles and bus, cab, and car curb lanes. Alternative 6 describes a new subway BART station under the existing (surface) parking facilities and the need for a new parking facility due to limited availability at the airport. The proposed configuration of Alternative 6 could conflict with the selected terminal development plan, since the plan envisions a peoplemover connection to BART with the expanded parking facilities to be provided for airport-related parking only. Suitable land for the BART parking facility envisioned in Alternative 6 is extremely limited due to the existence of potential sensitive habitat areas adjacent to the existing airport parking lots.

As part of the Master Plan Update, the Port of Oakland has prepared an Environmental Inventory. In 1987 an inventory was prepared for the Airport mapping Hydrophytic Plant Communities and Water Bodies. This has been submitted to the United States Army Corps of Engineers to make a jurisdictional determination regarding the presence of sensitive habitat areas. The Environmental Inventory has identified a number of hydrophytic plant communities and water bodies that could be impacted by Alternative 6. Moving from west to east, between the BART station and Doolittle Drive, the alignment would traverse, and potentially impact, the following types of sensitive communities: seasonable communities: 50 percent or more facultative hydrophytes, seasonal communities: 50 percent or more mixed hydrophytes, and non-tidal drainage channels.

- San Leandro General Plan

As the alignment of Alternative 6 moves east through Galbraith Golf Course, it leaves the City of Oakland and enters the City of San Leandro, to continue south along the alignment of the SPRR. The Land Use Element of the General Plan calls for major change in the area both north and south of Davis Street. South of Davis Street to the Estudillo Canal, "no change" is anticipated during the 15-year time frame of the General Plan. Finally, as the alignment for Alternative 6 turns east to connect with I-238, it traverses a single-family residential neighborhood which is designated as an area of "no change" by the General Plan.

Zoning along the path of Alternative 6 is also diverse, with the northern segment from Galbraith Golf Course to the Estudillo Canal zoned I-2 General Industrial along the length of the SPRR with the exception of an area of O Outer Residential zoning on the west side of the railroad line

between Marina Boulevard and Fairway Drive. C-4 General Commercial, C-N Neighborhood Commercial, and R-3 Multiple Residence zoning is located on lots on the western side of the intersection of the SPRR and Fairway Drive. The alignment turns east just south of the Estudillo Canal and passes through lands zoned for R-2 Multiple Residential and R-1 Single-Family Residence uses. Zoning for the lands at the interchange of the I-880 and I-238 Freeways is the same as described above under Alternative 4.

Historic and Cultural Resources

A review of the San Leandro General Plan listing of Major Historic and Cultural Resources indicates that no known resources are located within or adjacent to the alignment for Alternative 6.

- Oakland Comprehensive Plan and Zoning

The Land Use Element of the Oakland Comprehensive Plan was adopted in April, 1980. The Illustrative Future Land Use Map designates the Oakland Airport for Transportation Land Use. The alignment for Alternative 6 passes through the Galbraith Golf Course, designated as "Park, Recreation or Natural Area, or Watershed", then continues southeast into the City of San Leandro. The 1980 Generalized Zoning Map shows Industrial zoning for the entire airport area.

The alignment proposed by Alternative 6 would not be in conflict with the Comprehensive Plan land use designation or the generalized zoning designation.

3) Alternative 8: BART Transbay Tube

- Oakland Comprehensive Plan and Zoning

The Oakland Comprehensive Plan Land Use Element has a variety of land use designations that apply to the alignment of Alternative 8 as it leaves the Bay, travels over Port lands and connects with the Central Business District.

Alternative 8 leaves the Bay in a tunnel transitioning to an elevated structure near the Maritime Street overpass on Port lands designated by the Comprehensive Plan for Transportation land

use. Moving east along the Seventh Street corridor the alignment passes through lands designated for Institutional or Governmental and Commercial land uses. As the route parallels the south side of the Nimitz Freeway, the land use designation changes to Manufacturing or Wholesaling. Finally, the route turns north in a subway under the Commercial land use designations found in the Central Business District.

Generalized zoning designations for the alignment are Industrial, Special (for institutional or governmental uses), and Commercial through the Downtown.

The proposed alignment would not be in conflict with land uses envisioned by either the Comprehensive Plan or zoning designations.

- San Francisco Downtown Area Plan

The Downtown Area Plan is a component of the 1986 San Francisco Master Plan and contains objectives and policies to guide decisions affecting the downtown area of San Francisco. The alignment for Alternative 8 is totally subsurface as it traverses the area governed by the Downtown Plan; however, the following Objectives and Policies are relevant to the implementation of Alternative 8.

Objective 1, Policy #1: "Encourage development which produces substantial net benefits and minimizes undesirable consequences. Discourage development which has substantial undesirable consequences which cannot be mitigated."

Alternative 8 could be considered partially consistent with the policy above since it provides the net benefit of increased opportunity for transit ridership, and when operational would not have undesirable consequences. Construction impacts, discussed in Chapter 3.4 of this report, could be undesirable if cut-and-cover is deemed to be feasible at station locations. The depth of the final station design will determine whether or not cut-and-cover techniques can be employed and the duration of the construction period required. Market Street serves as an example of the long-term negative effect of this type of construction in the Downtown.

Objective 17: Develop transit as the primary mode of travel to and from Downtown. Policy #1: Build and maintain rapid transit lines from downtown to all suburban corridors and major centers

of activity in San Francisco....Policy #6: Make convenient transfers possible by establishing common or closely located terminals for local and regional transit systems."

Alternative 8 would appear to be consistent with Objective 17 and its supporting policies. The new BART line would encourage transit ridership in lieu of automobile travel and provide improved transit access for tourists, shoppers, and employees destined for Union Square. The alignment parallels Geary Street, one of the most heavily used transit corridors in San Francisco.

The Downtown Land Use and Density Plan[1] contains the following land use designations along the alignment for Alternative 8. The area along Mission Street and south of Market Street is designated for Downtown Office as the predominant commercial use type. The alignment crosses Market and continues west under Post Street where the land use designation is Downtown Office to Kearny Street, Downtown Retail from Kearny west to Powell Street, and Downtown General Commercial west of Powell Street.

Zoning designations for the land adjacent to the alignment of Alternative 8 correspond to the Plan designation. The area is within the C-3 Downtown Commercial District with a designation of C-3-0 (Downtown Office) for the area along Mission Street, land south of Market Street and along Post Street to west of Kearny, C-3-R (Downtown Retail) on Post from Kearny west to Powell Street, and C-3-G (Downtown General Commercial) from Powell to mid-block between Taylor and Jones.

4) Alternative 11: Inter-City Railroad Tunnel

■ Oakland Comprehensive Plan and Zoning

The Inter-City Railroad Tunnel Alternative would transition from a tube to surface level on lands designated by the Comprehensive Plan for Transportation use. As the alignment runs parallel to the Nimitz Freeway, the land use designation changes to Manufacturing or Wholesale and finally transition to Commercial at the foot of Broadway. The corresponding zoning designations are Industrial and Commercial. The alignment would not conflict with either the Plan or Zoning designations and would implement the uses envisioned in the Plan designation for Transportation

---

[1] San Francisco Master Plan, Downtown Area Plan, 1986, p. II.1.9.

and related uses. Further, implementation of an inter-city rail connection would facilitate the movement of goods between the Port of Oakland and the Port of San Francisco and would provide increased rail access for goods and services between the Peninsula and the East Bay.

- Mission Bay Plan

The Mission Bay Plan was adopted in September, 1990 and amends the various elements of the San Francisco Master Plan which apply to the Mission Bay area. Alternative 11 is an Inter-City Railroad Tunnel connecting with the proposed new underground CalTrain Station Fifth Street in Mission Bay. The Plan designates specific use districts for lands along the proposed (subway) alignment. The Mission Bay Plan amends the Municipal Code and Zoning Map for properties in the Mission Bay area and classifies the land use between Townsend and King Street and between Third and Fifth Streets as MB-O (Mission Bay Office District).

The Transportation section of the Mission Bay Plan describes a Mass Transit Objective to expand transit services to, from, through and within Mission Bay. Policy 2 states "Provide right-of-way for the extension of regional transit service to downtown from peninsula transit corridors." In the discussion, the Plan expands upon the mass transit potential by stating that "It is contemplated that by approximately the end of 1997, CalTrain will be extended to a Downtown Terminal.

An underground right-of-way for CalTrain under King Street is preserved for this extension. Every effort shall be made to minimize disruption of businesses along King Street during construction of the extension. CalTrain service to the King Street Station will provide regional transit service from the San Francisco peninsula transit corridors."[1]

Alternative 11 would appear to be in conformance with the policies and provisions outlined in the Mission Bay Plan for expanded CalTrain service. The alignment would enhance access from the East Bay and Peninsula cities for residents of Mission Bay. The greatest potential for conflict with the Plan is in the area of timing of the improvements. If the proposed office uses are constructed prior to the underground station proposed by Alternative 11, construction of the new station could have significant impacts. (See also Chapter 3.4, Construction Impacts.)

---

[1] Mission Bay Plan, Op. cit., pp. 3-110.

Land Use

Introduction

The land use analysis will describe existing land use patterns adjacent to each of the proposed alternatives. The effect of construction and operation of each alternative upon existing land use patterns will be assessed with emphasis on displacement of housing and businesses.

Alternative 1: High-Speed Ferry System

This alternative would provide high-speed ferry service at 17 locations, six in northern bay area communities north of the Bay Bridge, and 11 in southern bay area communities, south of the Bay Bridge. Northern bay communities served by the ferry would include Berkeley, Richmond, Vallejo, Benicia, Rodeo, and Martinez. Central and southern bay communities would include Oakland, Alameda, San Francisco (two facilities -- Ferry Building and Mission Bay), South San Francisco (Oyster Point), Bay Farm Island, Oakland Airport, San Francisco Airport, San Leandro, San Mateo (Coyote Point), and Redwood City. Proposed land use activities associated with each of the land-side terminal facilities would include the following: 1) docking facilities to accommodate vessels in all tidal conditions, 2) terminal facilities with ticket sales, passenger waiting areas and other services as necessary, 3) parking facilities to accommodate 500 to 1,000 vehicles, 4) intermodal transfer facilities to interface with bus feeder systems, 5) access roads, and 6) a long-span loading pier for areas with shallow water depths. A terminal facility would require between one and two acres since most of the selected sites have existing parking facilities. It is anticipated that the existing parking facilities could be expanded or developed with a parking structure, minimizing the requirement for additional acquisition of land. In Rodeo, where marina parking facilities are minimal, up to five acres could be required to accommodate a full terminal facility. In Richmond and Redwood City, up to five acres of industrial land in the seaports would have to be converted to public uses for the ferry terminal and parking.

As discussed in previous sections of this report, seven of the proposed terminal locations now have ferry service or had it during the post-earthquake months (San Francisco Ferry Terminal, Oakland, Alameda, Vallejo, Richmond, Berkeley, and Bay Farm Island. Land use impacts, at a minimum, would involve upgrading and/or expansion of existing land-based facilities (e.g., increased parking, expanded, or upgraded terminal facilities, etc.). It is not anticipated that a

significant number of businesses or residents would require relocation as a result of expanding or upgrading facilities.

Six of the identified terminal locations would be located in existing ports or marinas (Martinez, Rodeo, San Leandro, Oyster Point, Coyote Point, and Redwood City). Land use considerations relevant to each of the six locals are briefly described as follows:

- Martinez -- The proposed Martinez facility would be located near a former ferry terminal at the existing Martinez Marina, or inside the marina, which is protected from exposure to weather and contains sufficient water depth. The terminal site borders the Martinez Regional Shoreline Park and Waterfront Park. The distance from the ferry terminal to available parking sites would require a fairly long walk for ferry commuters and could result in a need for shuttle service. Crossing of the main Amtrak line, which is busy during the peak hour, could affect patronage and raise safety concerns.

- Rodeo -- A potential location for the Rodeo terminal would be north of the Lone Tree Point Natural Area, within the protected waters now occupied by two private marinas, Joseph's Resort Marina and Bennett's Marina. The ferry could stop at either Marina and the proposed facility could serve as a catalyst in upgrading the marina and shoreline area. As with the Martinez facility, the primary constraint to development of a complete terminal facility is locating an appropriate site for parking. East Bay Regional Park District has purchased an 11-acre parcel of land to the south of the Marinas, which may be able to be jointly developed for parking in support of recreational and ferry service activities. Parking would have to be located across the railroad tracks from the proposed terminal causing potential safety concerns during peak train service hours.

- San Leandro -- San Leandro Marina is owned by the City of San Leandro and is presently developed with a well-protected marina, support facilities, yacht club, restaurants, extensive park amenities, and parking. Development of a ferry terminal at this site could impact other activities and would preclude other uses on the remaining land available for development in the marina. The city is currently in the process of preparing a new Specific Plan for the marina area.

They have expressed concern that adding a ferry terminal to the marina could have a negative impact on parking availability, in addition to constraining development potential.[1] Water depth would have to be increased to accommodate ferries and new construction would be required for docking and terminal facilities.

- Oyster Point (South San Francisco) -- The terminal facility could be located in one of two marinas -- Oyster Cove Marina or Oyster Point Marina. These marinas are located in an area of developing industrial parks with sufficient vacant land or potential for shared parking facilities as part of an employer's transportation systems management plan. Water depth would be sufficient to handle ferry service.

- Coyote Point (San Mateo) -- Coyote Point Marina is a well-protected marina located close to employment centers, numerous hotel facilities and recreational opportunities. The site offers good opportunities for an intermodal bus facility to CalTrain stations in Burlingame and San Mateo.

- Redwood City -- The proposed terminal could be located at any one of several candidate wharf areas in the Port of Redwood City. The potential sites are protected and the channel is sufficiently deep. Environmental considerations might require reduced speeds in the channel or use of a hovercraft as an alternative ferry type.

Finally, four of the proposed terminal locations would involve new facilities (Benicia, Oakland Airport, San Francisco Airport, and Pier 24). A description of these facilities and existing land use characteristics are presented below.

- Benicia -- Several potential sites exist in the Benicia area; however, Planning Department staff has indicated a preference for a ferry stop at the foot of Fifth Street with a possible secondary stop at the end of Second Street. These areas

---

[1] Martin Vitz, City Planner, Community Development Department, City of San Leandro, Personal Communication, August 20, 1990.

are currently undeveloped and sufficient area may be available for parking, access roads and intermodal transfer stations. Limited water depth and exposure to wind and waves are potential constraints to be mitigated at the Benicia location(s).

- Oakland Airport -- A possible terminal location exists south of Terminal 2. Protection from the weather could be designed into the terminal, but present water depth is insufficient for the proposed ferries. Increasing the depth of the channel would have significant environmental implications which could be avoided by using a long span pier or a hovercraft to provide access for passengers. The hovercraft, however, would result in its own impacts due to the necessity of its coming ashore to land and load/unload passengers. Available existing or future land area at the airport for non-airport uses is unlikely. (See, also, discussion in Section 3.1 Compatibility with General Plans and Zoning Policies, page 3-9, Oakland Airport Master Plan.) Providing a parking facility proximal to the ferry terminal could be constrained inasmuch as available land is proposed for other airport-related uses and the existing parking lots currently operate at or near capacity.

- San Francisco Airport -- The proposed facility would be located at the existing seaplane terminal. Limited protection from the weather exists here and it is likely that an increase in channel depth would be required. Current land use in the area is industrial.

- Pier 24 -- Pier 24 is proposed as an example of a San Francisco location, other than the Ferry Building, which might be serviced by the ferry system. Pier 24 is located under the Bay Bridge in the Rincon Point Redevelopment area. Water depth is sufficient and the location offers good potential for intermodal transfers to bus, CalTrain, and Muni Metro. Construction of docking, terminal, and parking facilities must be integrated into the waterfront development.

<u>Alternative 4: Interstate 380 to 238 Bridge Connection</u>

Alternative 4 involves the construction of a bridge connecting Interstate 380 in the West Bay to Interstate 238 in the East Bay with eight lanes of vehicular traffic and BART providing rail service.

The main span would be orthotropic with trestle bridges on each approach, similar to the San Mateo-Hayward Bridge. This alternative also contains a subalternative (4A) with a southerly alignment on the East Bay segment following San Leandro Creek from the Bay to the Nimitz Freeway.

West Bay Segment

The bridge approach from the Bay would consist of a trestle span, 15 feet above the water, that would split into two separate approaches before reaching the West Bay shoreline. The northern approach is the BART element. Moving from east to west, the BART line reaches the shoreline just west of the San Bruno canal, and continues west over the canal, Colma Creek, and the San Francisco and San Bruno Sewage Treatment Plant, at a height of 15'. The BART line would then connect with a new aerial station at South Airport Boulevard. The alignment would continue west in an elevated structure crossing over Airport Boulevard, power transmission lines, U.S. 101, and the SP tracks to transition to an at-grade alignment at the BART SFO extension. Land uses in the area east of the Bayshore Freeway are characterized by a mix of commercial and industrial uses, most of which are airport-related such as hotels, motels, car rental agencies, restaurants, service, and industrial uses. Land uses west of the Bayshore are light manufacturing, office/warehouse, auto repair, vehicle and equipment rental. Some of these uses would be displaced by the BART alignment.

The southern half of the alternative involves a bridge to connect with I-380. The trestle bridge would reach the shoreline and continue in an aerial structure to connect with I-380 at a freeway-to-freeway interchange with the Bayshore Freeway (U.S. 101). Land uses in this area consist almost entirely of airport support services including a major employer, the United Airlines maintenance facility. The alignment as envisioned would stay close to the shoreline, roughly along the North Access Road, to minimize business disruption and displacement.

East Bay Segment

The East Bay Segment would traverse the City of San Leandro from the Bay to the connection with Interstate 238, creating significant land use impacts on commercial and residential uses in the vicinity of San Leandro/San Lorenzo. This vicinity is a largely built-out, stable community with

very little undeveloped land; as a result, Alternative 4 would displace a significant number of homes and businesses along the length of its alignment.

The physical structure for the East Bay segment of this alternative would involve an elevated and at-grade freeway with the BART line in the median. Moving from east to west, the new freeway would connect with Interstate 238 just east of the freeway interchange of Interstate 880 and Washington Avenue. The grade separated structure would span over the Washington Avenue overpass at I-880 and transition to an at-grade facility along the Manor Boulevard alignment. Approximately 200 feet east of the Southern Pacific Railroad, the elevation of the highway would rise to provide an overpass that would span the railroad and continue in an elevated structure along the flood control canal to connect with the trestle bridge crossing the Bay. BART, as mentioned above, would be constructed in the median of the freeway, with new stations at the junction of the Fremont and Dublin/Pleasanton line, and to the west at the Southern Pacific Railroad overpass.

Land use impacts east of Interstate 880 involve commercial retail uses. A full interchange could displace a portion of San Leandro's major retail center located in the triangle of land formed by Lewelling, Washington, and Interstate 280. To the north of the 238 Freeway, a full interchange would displace all or a portion of the residents in the 840-unit Lakeside Village apartment complex.

Land uses between Interstate 880 and Wicks Boulevard are predominately residential. The alignment of the proposed freeway would follow Manor Boulevard, which is developed with established single-family homes, neighborhood retail uses, a library (Manor Branch), a post office, and St. Felicitas Church and Elementary School. This section of the freeway would be at-grade, creating a physical barrier dividing the neighborhood and creating noise and vibration, and visual and air quality impacts. Assuming that the right-of-way required to develop the freeway would take only the lots fronting on Manor Boulevard, approximately 110 - 120 residential units would be displaced and the residents required to be relocated. In addition, businesses along the Manor Boulevard corridor located at the intersection of Farnsworth, between Zelma and Norton, and east of Alexandria to I-880 would be displaced.

West of Wicks Boulevard, land uses transition to a mixture of industrial, residential and commercial recreational uses. The profile of the proposed freeway transitions at this point,

crossing the Southern Pacific Railroad with an elevated BART station and continuing west at a lower elevation of 15 feet above grade. The BART station would require the development of parking facilities which could create impact on wetlands if developed to the southwest, on single-family residences if developed on Manor Boulevard, and displacement of existing industrial uses if constructed to the north.

The freeway structure is proposed to be built on structural bents straddling the flood control canal to minimize the need for acquiring additional right-of-way or disturbing wetlands. Moving west from Wicks Boulevard, land uses are industrial on the north side of the channel with designated Section 404 wetlands to the south of the canal. Immediately west, the northern side of the canal is developed with single-family condominiums. The south side of the canal is vacant and approved for use as a dredge material storage area for disposition of dredge spoils from the San Leandro Marina. This area is critical to the long-term use of the San Leandro Marina and the City is in the process of acquiring the land from Citation Homes, with whom they have a "Pre-Development Memorandum of Understanding" dated July 1990.[1] Subsequent studies of this alternative should assess the total amount of land required to provided adequate footing for the elevated freeway structure and the impact upon Marina Park facilities, the dredge spoils site and wetlands.

Moving westerly to the Bay, the remaining land is developed with the Tony Lema Golf Course, an 18-hole course spanning the flood control channel connected by a pedestrian bridge over the canal. East Bay Dischargers Authority operates a dechlorination facility at the levee on the south side of the canal at the terminus of Neptune Drive. The Bay Trail is located along the shoreline. Construction and operation of the proposed freeway would have negative effects on these existing recreational amenities due to noise, visual impacts, and air quality impacts. The eight-foot force main "super sewer" is located within an alignment parallel to the bay which would be crossed by the proposed bridge alignment, necessitating special care in the location and design of footings, continuous provision of access for maintenance, and coordination of design with the sewer, dechlorination facility, and outfall. San Leandro has expressed concern that Alternative 4 would cross the Jack D. Maltester Federal Channel which provides boat access to the Bay from San Leandro Marina.

---

[1] Op. cit., Martin Vitz.

Alternative 4A would reduce the land use impacts of the East Bay Segment somewhat, as compared to Alternative 4. The proposed alignment would impact major commercial uses at the interchange of I-880 and I-238 which could result in the displacement of some businesses between Hesperian Boulevard and Washington Avenue. West of Washington Boulevard the freeway alignment would pass through a corner of commercial (Greenhouse Marketplace) and multi-family residential uses before reaching the alignment along San Lorenzo Creek. Tenants of both residential and commercial units could be displaced at the southwest corner of Lewelling and Washington.

The alignment continues along the creek, west to the railroad tracks. Land uses on both sides of the creek are single-family residential; those on the north side are in the City of San Leandro, while on the south side homes are in San Lorenzo. Construction of a freeway along this alignment would have unavoidable adverse noise, visual, air quality, and dust effects on students at Arroyo High School, south of the creek. Impacts of this alignment, while it may not displace homes, would be significant as a result of freeway generated noise, vibration, dust and particulates, and visual impacts due to the height and bulk of the elevated structure.

Alternative 6: BART Airport Connection

Alternative 6 is a BART-only extension traveling under the Bay to a primarily below-grade structure on the land side of the West Bay, and a predominately elevated structure on the land side of the East Bay.

West Bay Segment

The BART SFO Extension will extend service from Daly City/Colma to the San Francisco Airport along the Southern Pacific Railroad right-of-way. The terminus for Alternative 6 would be the currently proposed Airport BART station on the west side of U.S. 101.

Moving from east to west, the BART tube would transition from an underground tunnel to a surface level track, surfacing at the Southern Pacific Railroad tracks. The line would then continue north along the SPRR right-of-way to the Airport Station. Construction methods for the portion of the line between the shoreline and the intersection with the SPRR right-of-way would be to bore a tunnel, which should minimize surface land use impacts. The tunnel would traverse under a sewage treatment plant and a single-family residential subdivision. The subdivision is

located adjacent to the SPRR tracks, and, depending on construction methods and the exact location where the tunnel would surface, an unknown number of residents could be displaced. The portion to the north along the SPRR ROW could be accomplished within the existing right-of-way and would not require acquisition of land or displacement of land use activities.

East Bay Segment

The eastern section of this segment would be similar to Alternative 4, with BART in the median of Interstate 238. West of the junction with Interstate 880, the BART-only line would continue in an elevated structure following a general alignment approximately 1,000' south of Manor Boulevard, gradually turning north on the west side of Wicks Boulevard to follow the railroad right-of-way. Similar to Alternative 4, this portion of the alignment would have significant impacts on this established residential neighborhood. Land uses in this area consist of established single-family residences, Washington Manor Junior High School, Dayton Elementary School, and St. Felicitas Elementary School. Alternative 6 would place an elevated BART structure over the local streets of an established single-family neighborhood with the attendant impacts resulting from noise, vibration, and creation of a visual barrier dividing the neighborhood. Assuming that BART would require a right-of-way width of approximately 50 feet, the number of homes displaced in this section could approximate between 50 to 70. Washington Manor Junior High School would be displaced, and Dayton Elementary and possibly St. Felicitas Elementary School would be impacted.

BART would continue north in an elevated structure to an elevation station at Marina Street, passing through an industrial area until Fairway Street. North of Fairway Street, industrial uses predominate with the exception of a residential subdivision on the west side of the SPRR between Fairway and Marina Boulevard. Continuing north from the Marina station, the tracks would transition to an at-grade facility, north of Williams to Davis Street. From the point where the BART line intersects with the SPRR right-of-way, north to Davis Street, the land use impacts would be minimal, as no homes or businesses would be displaced. The majority of land uses adjacent to the line are industrial and the railroad has established the alignment as a transportation corridor with attendant noise, visual, and related impacts.

Approximately 1,000 feet north of Davis Street, the BART tracks would transition to an elevated structure to cross over Doolittle Drive, then curve to the west to parallel the south side of Airport

Drive along the approach to the Oakland International Airport. The tracks would then transition to an at-grade facility and then into a subway facility approximately 1,000' east of the loop road serving the two airport terminals. A new subway station would be provided under the existing parking lot, then the BART tracks would turn south to enter the transbay tube. The BART tracks pass through established industrial land uses in the City of San Leandro until leaving the SPRR right-of-way to turn west through the City of Oakland's Galbraith Golf Course. From Doolittle Drive west, this alignment would be passing through airport lands. As discussed in greater detail in Section 2.2 Ecology, and 3.1 Consistency with General Plans and Zoning, airport lands are constrained by a number of important factors, including sensitive hydrophytic plant communities and water bodies, and potential conflicts with existing and future airport master planning activities (e.g., locating airport short-term and long-term parking facilities).

Alternative 8: BART Transbay Tube

Alternative 8 would provide a new transbay tube, parallel to the existing tube, and would provide increased capacity between San Francisco and the East Bay.

West Bay Segment

Alternative 6 would be subsurface for the entire alignment in the West Bay, with new stations at Mission Street, with a pedestrian tunnel connection to the existing Embarcadero station under the existing Montgomery Street Station and Union Square, with a terminal at Post Street. This alignment, one of many possible options through San Francisco, would terminate at a stub end station just west of Leavenworth Street. Assuming that the predominate construction method would be to bore a tunnel under existing streets, with cut-and-cover construction to be used for new stations where and if feasible, surface land use impacts for the West Bay segment would be moderate once the system is in operation. (See also Section 3.4 Construction Impacts.)

East Bay Segment

The proposed BART tracks would parallel the existing transbay tube in a subway facility between the shoreline and the Maritime Street overpass, transitioning to an aerial structure east of Maritime. Two additional tracks would be provided at the elevated West Oakland station. At Martin Luther King, Jr. Way the tracks would begin the transition to a subway through downtown Oakland. A new fourth track would bypass the Oakland wye and connect to the system again at the 12th Street Station. No new BART stations are proposed although modifications will be required at existing stations to accommodate the new service. Since the new BART alignment would parallel the existing alignment throughout the surface portion of the new line, land use impacts will be minimized. Tunneling, rather than cut-and-cover construction methods, are proposed to be used through downtown Oakland, resulting in insignificant surface and use impacts.

Alternative 11: Inter-City Railroad Tunnel

Alternative 11 involves the construction of a two-track rail tunnel providing passenger and freight service between the East Bay and West Bay.

West Bay Segment

The railroad connection would terminate at the proposed CalTrain station at Fifth Street in a subway facility under the existing SPRR yard, adjacent to Townsend Street. The proposed station would be located on a site parallel to the proposed CalTrain station, with a tunnel connecting the two. The railroad connection would transition to a subway from the Fifth Street subway station at a 2 percent grade toward the San Francisco shoreline. Alternative 11 would be compatible with existing and proposed land use in the Mission Bay area, providing improved access from the East Bay to the Peninsula and a connection with Muni to downtown San Francisco.

East Bay Segment

The East Bay segment for Alternative 11 will transition to a surface structure and connection with the existing Union Pacific Railroad track approximately 2,500 feet east of the shoreline. The alignment would follow the Union Pacific Railroad corridor, continuing to a split to the north and south. This alignment would closely parallel and be compatible with existing railroad activities. Land use impacts from this alternative are insignificant.

Visual Quality

Introduction

The following section assesses the impacts on visual resources resulting from each of the alternatives. The discussion focuses on long-term effects of the completed project. Short-term, temporary impacts are discussed in the following chapter on Construction Impacts.

Alternative 1: High-Speed Ferry System

The San Francisco Bay Plan, as discussed in Chapter 3.1 of this report, specifically addresses the impacts upon visual resources on and around the Bay. Policy #4 is relevant to the ferry alternative: "Structures and facilities that do not take advantage of or visually complement the Bay should be located and designed so as not to impact visually on the Bay and shoreline. In particular, parking areas should be located away from the shoreline."

Visual impacts as a result of implementation of the high-speed ferry system would be minimal for several reasons. First, the majority of the 17 ferry terminal sites would be located in, or nearby, existing ports or marinas. Secondly, land-based activities are limited to terminal facilities, docking facilities, parking lots, and loading piers, where needed. These activities would require between one and five acres and could be sensitively designed to minimize impacts where resources are present. Third, the Bay Plan specifically states that parking areas should be located away from the shoreline which could be accomplished with the ferry system alternative through sharing existing parking facilities, designing new facilities to include significant landscaping requirements, and locating the new facilities back from the shoreline.

Alternative 4: Interstate 380 to 238 Bridge Connection

Of the five alternatives evaluated in this report, the I-380 to 238 bridge connection has the most significant visual impact on the Bay, shoreline, and neighborhoods. The bridge would be an orthotropic structure in the main span and trestle bridges on each approach, similar to the San Mateo-Hayward Bridge. However, the bridge would be considerably wider than the San Mateo, with an eight-lane cross section for autos and HOVs. BART would be located on the lower level of the bridge in the main structure spanning the shipping channel and in the center of the trestle bridge on both approaches. At more than 12 miles in length, the new bridge would be the longest unbroken span over the Bay, resulting in significant visual impacts.

The San Francisco Bay Plan, Appearance, Design and Scenic Views chapter, also specifically addresses new bridge crossings in Policy #6: "Additional bridges over the Bay should be avoided, to the extent possible, to preserve the visual impact of the large expanse of the Bay. The design of new crossings deemed necessary should relate to others nearby and should be located between promontories or other land forms that naturally suggest themselves as connections reaching across the Bay (but without destroying the obvious character of the promontory). New or remodeled bridges across the Bay should be designed to permit maximum viewing of the Bay and its surroundings by both motorists and pedestrians. Guard rails and bridge supports should be designed with views in mind." The new bridge would conflict with most of Policy #6. It traverses a large expanse and is not located between promontories or other obvious land forms. The bridge could be designed to permit Bay views with guard rails and bridge supports designed to accomplish this.

The landside visual effects are also significant in the East Bay segment of Alternative 4. The alignment is elevated between the shoreline and the BART station over the SPRR line. The size, bulk, and scale of the bridge structure and approaches would have a visual impact on recreational activities and residential uses to the north and south. The most significant visual impact would occur where the alignment follows Manor Boulevard, bisecting an existing single-family neighborhood and visual dividing the community. The freeway would be at-grade along Manor Boulevard, maximizing the visual barrier and precluding crossings except at underpasses or overpasses.

In the West Bay, visual impacts would be less significant since the alignment passes through an established industrial area. Vistas from the shoreline would, however, be impacted.

Alternative 4A would have less of a visual impact than Alternative 4 since the structure would be located over an existing concrete flood control channel (San Lorenzo Creek) which presently serves as a visual barrier between residential neighborhoods in San Leandro and San Lorenzo. However, the height and mass of the freeway in addition to the light and glare impacts, would create a significant impact and elevated visual barrier between the two communities.

Alternative 6: BART Airport Connection

Alternative 6 would not have significant visual impacts on views to and from the Bay since the alignment is in a tunnel crossing the Bay and is below grade in the West Bay segment until the transition to the elevated BART station west of the airport. Visual impacts in the East Bay, however, would be significant, particularly for neighborhoods in the City of San Leandro which would be visually divided by the elevated BART structure.

As the BART line transitions from a subway to elevated structure and heads south along the existing SPRR alignment, impacts would be minimized since the area is predominately industrial, with the exception of the Mulford Gardens residential area south of Marina Boulevard and west of the SPRR line. As the line turns to the east it traverses through the middle of an existing single-family residential area, resulting in significant visual impacts. These impacts would be less than those associated with Alternative 4 since the right-of-way needed is less and the land beneath the aerial structure could be used for landscaped open space, bikeways, and jogging paths as has been done in communities such as Albany. However, since the BART structure would be elevated and is located in the middle of an established single-family neighborhood, rather than along a major or secondary highway, visual impacts would be regarded as significant.

Alternative 8: BART Transbay Tube

Alternative 8 is envisioned as a completely underground alignment in the West Bay, therefore, visual impacts during operation of the alignment would be insignificant. Construction impacts are discussed separately in Chapter 3.4 of this report.

In the East Bay segment, Alternative 8 is underground throughout the downtown area resulting in no visual impacts. The elevated portion of the alignment parallels an existing BART line, and would not create any new visual impacts through an area of industrial and port-related activities.

Alternative 11: Inter-City Railroad Tunnel

The Inter-City Railroad tunnel is to be operated underground in the West Bay resulting in no visual impacts on surface land use. In the East Bay, the alignment follows existing railroad tracks through areas that are currently used for activities (industrial, transportation, military, and port-related) that would be compatible with the proposed rail use. Visual impacts with Alternative 11 are insignificant.

Construction Impacts

Introduction

Construction impacts are short-term and temporary in nature; however, during the term of construction, impacts associated with major projects such as a bridge or tunnel crossing, San Francisco Bay can be expected to be significant. The following discussion will provide a generalized examination of the relative impacts generated by each of the alternatives during the construction phase. Issues to be examined include those summarized from other sections: geology, air quality, visual, and noise and vibration. The duration of the construction activity is an important factor when considering temporary impacts. The construction period for the ferry terminal facilities (Alternative 1) is expected to be approximately 1-1/2 years for each pair of terminals. The Alternative 4 bridge, which includes BART, is projected to take between two and three years to construct. The tunnel alternatives (Alternatives 6, 8, and 11) are of the longest duration, between 2-1/2 and 3-1/2 years.

Alternative 1: High-Speed Ferry System

Construction impacts at the 17 identified ferry terminal locations would vary considerably, with the most pronounced impacts at the locations that do not have ferry service at present. Impacts would result from the combined land and water facilities required, including construction of docks, terminal buildings, parking lots or structures, access roads and, in some cases, a long-

span loading pier. Construction noise and visual impacts would be more significant at locations with existing recreational, residential, or commercial uses located adjacent. Shipping and land-based movement of goods and services could be negatively impacted during construction.

Alternative 4 and 4A: Interstate 380 to 238 Bridge Construction

Alternative 4 and 4A involve an at-grade or elevated bridge structure for the entire length of the alignment. In the West Bay segment, the bridge and approach connectors would be constructed on pilings which pass through areas of very high to extremely high susceptibility to groundshaking during an earthquake. The West Bay segment traverses a predominately industrial area where sensitive noise receptors are less likely to be found and visual impacts would not be significant.

The transbay segment would be constructed in a manner similar to the San Mateo Bridge. Modern engineering and construction techniques can reduce the potential for serious damage during a seismic event. Shipping could be disrupted during dredging activities.

The East Bay segment of Alternative 4 and 4A would require substantial land acquisition. The alignment runs through established single-family residential neighborhoods and would result in major adverse construction impacts. Dust from grading, earth movement and facility construction, noise and vibration from pile driving and other activities, and visual impacts would be significant, requiring development of a major mitigation program. Construction procedures may need to be modified to accommodate the "super sewer" which parallels the East Bay shoreline.

Alternative 6: BART Airport Connection

The West Bay segment of the BART Airport connection would be constructed below grade, transitioning to an elevated BART station west of the airport. As with all the alternatives, the alignment passes through areas of very high to extremely high susceptibility to groundshaking. The transition structure is in an area with potential maximum intensities of groundshaking ranging from violent to very violent. ABAG Cumulative Damage Potential maps indicate very high cumulative damage potential for concrete and steel structures along the west side of US 101. A portion of the alignment, between US 101 and the SPRR line, passes through a residential area

where residents would be negatively impacted by construction and excavation dust, noise, and vibration.

Construction techniques for the transbay segment involve installing a tube in a dredged trench beneath the Bay, using a siphon dredge. The tube sections would be installed in the trench and covered with backfill material.

The East Bay segment would transition from a tube beneath the Bay, with an underground station at Oakland Airport, and a surface and elevated structure after leaving the airport area. The middle portion of the alignment runs along the SPRR line which is primarily bordered by industrial land uses where construction impacts would be low to moderate.

The southernmost portion of the East Bay segment, between the SPRR and I-880, runs through the middle of an established single-family subdivision. As with Alternative 4, impacts on residents in the areas of air quality and dust, noise and vibration, and visual impacts, are expected to be significant and adverse.

Overall, construction impacts from a BART-only alignment in the East Bay would be less significant than those for the large and wider facility required for a freeway in Alternative 4.

<u>Alternative 8: BART Transbay Tube</u>

The BART transbay tube would use different construction techniques for each of the three segments. The West Bay segment would probably require boring rather than the less costly cut-and-cover construction, due to the depth of the tube below ground level and the difficulty of providing passenger access from ground level to a very deep station. Three new BART stations are proposed in the alternative: 1) Mission Street, paralleling the existing Embarcadero station, 2) under the existing Montgomery Street station, and 3) Union Square under Post Street. If cut-and-cover is found to be a suitable technique for construction of the Union Square and/or Mission Street stations, the impacts could be potentially significant, particularly along retail corridors, as evidenced by the impact of BART construction on Market Street.

Construction techniques for the transbay segment are described in Chapter 2.3, Dredging and Water Quality, and involve installing a tube in a dredged trench in the Bay and backfilling with fill material and rock to protect the tube.

The East Bay segment is proposed to be bore construction through downtown Oakland and an elevated structure between Maritime to Martin Luther King, Jr. Way.

Alternative 8 would not cross any active faults; however, the alignment would pass through the area with moderately high to extremely high susceptibility to groundshaking. Noise and vibration resulting from the use of heavy equipment and construction procedures can be expected to be significant in and around the construction site, particularly at stations. Dredging activities could disrupt heavy shipping activity into and out of the Port of Oakland, Port of San Francisco, Alameda Naval Air Station, and Hunter's Point Naval Shipyard.

Alternative 11: Inter-City Railroad Tunnel

The West Bay segment of Alternative 11 would be primarily cut-and-cover construction from the Fifth Street station to Third Street. From Third Street on across the Bay, the tube would be bore construction. As discussed in previous sections, the timing of development in Mission Bay is critical to the level of impact that would be created by Alternative 11. If Mission Bay development were to occur prior to construction of the new station, then dust, noise and vibration, visual, and land use impacts would be significant.

The transbay construction methods and resulting impacts would be similar to those discussed in Alternative 8.

Construction impacts in the East Bay segment could have a significant impact on railroad operations. Land use in the area is industrial or institutional with low to moderate impacts anticipated due to dust, noise, groundshaking, or visual impacts.

Figure 5-2

SUMMARY OF LAND USE IMPACTS

5.4 GROWTH INDUCING IMPACTS

Background

Transportation, economic growth, and land development have always been important and interrelated ingredients in the growth and shaping of industrial and post-industrial urban communities. Early American cities formed at advantageous positions on waterways and drew their primary economic sustenance from the shipment and distribution of waterborne goods. A century later the railroads tended to reinforce the fabric of urban development, while expanding it into new areas without the benefits of good access to waterways. In the early part of the 20th century, when cities were booming due to industrialization and immigration, and the automobile was making an entrance, land use planning was in its infancy and transportation was chiefly put in place to serve promoters and developers. While the Depression and World War II drastically slowed the expansion of urban areas, zoning was implemented, giving a measure of protection to existing land uses. The slow spread of urbanization in this era, as well as gas, steel, and rubber rationing during the War, reinforced the use of transit systems.

There were no shortages of families being formed, raw materials, land, or capital in the post World War II period. Economic growth was manifested in the suburbs. Transportation by automobile was preferred and a lattice-like grid of local streets and arterials, regional thoroughfares, and inter-regional freeways were built to serve the expanding suburban areas. In the late 1950s, the Federal Government became involved as a major financial contributor enabling even greater expansion of intrastate and interstate freeways. Transportation continued to serve and reinforce the trends of development -- at the expense of the old transit systems, and with threats to the old central cities, good farmlands on the fringes, the quality of the air, and other factors. Although the public had, by and large, been excluded from the complex transportation planning and engineering process, some were beginning to question whether the suburban developers, planners, and road builders had a monopoly on wisdom. The freeway revolt of the '60s began and the debate continues.[1]

---

[1] Drawn from Garrison, W.L., "Urban Transportation and Land Use," in *Public Transportation*, Gray; Hoel, eds., pp. 515-520.

Transportation and Land Use

Central to the continuing debate is the relationship between transportation investments and land use. The suburbanization of America could not have occurred without cars and the development of roads and freeways. However, the roads and freeways would not have been built had there not been strong demand for residential, commercial, and industrial activities plus active promoters, ready and willing to undertake development. Clearly the relationship between transportation and land use is multi-faceted and complex.

When proposed in the mid-1960s, the BART system was promoted as growth inducing. It was designed to supply a tremendous increase in accessibility to downtown San Francisco, in support of the City's large redevelopment plans and projects. Similarly, the promoters claimed it would also supply the essential accessibility that would make downtown Oakland into a major regional center. In addition, the designers expected stations in suburban centers to attract major concentrations of offices and retail shops, while outlying stations would become surrounded by high-density housing and shopping facilities.[1] While significant economic growth has occurred in the Bay Region since BART was opened, the studies on the impacts of the BART system reveal that its effects on growth were not as great as anticipated.

To begin with, BART patronage has been consistently lower than was projected when it was designed; BART carries only about 3 percent of the region's trips. While it has diverted some automobile trips from freeways (albeit many fewer than projected), the "Law of Traffic Congestion"[2] has taken effect and other people have begun taking trips they would otherwise not have made. The overall mobility in the region has increased to fill the available space on the roads and freeways. While the increase in transportation capacity did generate new trips, many of these new trips are not the result of new land development.

While downtown San Francisco has, just as predicted, grown enormously in the time since BART service began, no one can prove that there is a cause-and-effect relationship between the new

---

[1] Webber, Melvin, "The BART Experience - What have we learned?", *The Public Interest*, Fall 1976, p. 82.

[2] Webber, op. cit., p. 85. The "Law" holds that traffic expands to fill available highway space until just tolerable levels of congestion area reached.

transit system and Downtown's growth. In the 12 years after BART opened, San Francisco's high-rise office buildings were expanded by 4,200 square feet for every 1,000 people in the region. But in the same time, Houston added 5,500 square feet per 1,000 people, Chicago 4,550, and Dallas 3,500.[1] The accelerating expansion of service activities during the past several decades has coincided with the strong determination of many cities to revive their downtown. If transportation capacity is a primary causal factor in the success of downtown growth, then why did cities like Houston, Dallas, New York, and Denver grow without huge new transit systems? Why did Oakland, at the hub of the BART system, grow much more slowly than any of these cities and than predicted by the BART proponents? Why were Sonoma, Solano, and Santa Clara the fastest growing counties in the Bay Area during the '70s while none of them had any new freeways or transit systems?

As noted above, the relationship between transportation and land use is exceedingly complex. Careful attempts to isolate cause-and-effect relationships have consistently faltered under rigorous examination. Fundamentally, transportation improvements support growth, while land use development generates new travel demand and hence the need for new transportation capacity. However, some transportation improvements may not affect growth at all. Most TSM programs would fall in this category, as might many HOV lanes, and express bus and congestion management efforts. Some projects, like new interchanges or freeway links that provide access to areas where development is planned, induce growth on a local scale, or at least, are effective in directing its location. On a larger (regional) scale, however, few projects are likely to induce growth that would not have been expected and was not planned. BART was expected to have been such a project, but most analysts seem to concur that its effects on growth have not been large.

Most transportation projects, by far, are in the wide gray area between no effect and growth inducing. These are projects that may hasten growth in a certain area (and retard it in others), or intensify development in certain locations (as BART has intensified residential densities near some suburban stations), or shift growth from one local to another. In this gray area other factors, particularly local planning and community standards or environmental initiatives, direct the location and timing of transportation investments. For example, the "freeway revolt" in San Francisco stopped the extension of I-280 across the waterfront to the Golden Gate Bridge.

[1] Webber, op. cit., p. 89.

Similarly, the Local Coastal Plans under Proposition 20, the Coastal Act, have led to the removal of a number of coastal serving road widenings and proposed freeway links from the State Transportation Plan. In the Bay Area, the Coastal Plans have probably directed some growth, and transportation investments, from the West Bay toward Contra Costa and eastern Alameda Counties.

Analysis

The economic and population growth that the Bay Area has witnessed in the past four decades is expected to continue. ABAG's *Projections 90* estimate that the nine Bay Area counties will experience population gains of about 1.4 million people between 1980 and 2000, comparable to the 1.5 million person increase between 1960 and 1980.[1] Today there are more jobs in the nine Bay Area counties than there are employed residents, leading to significant in-commuting from surrounding areas. This trend is expected to continue. ABAG estimates that between 1990 and 2005 the region's economy will create 880,900 new jobs, but will only accommodate 588,800 new employed residents, a ratio of 1.5:1. While the shortage of housing could stifle job growth, to some extent it will also create a demand for the densification and infill of existing urban areas and for improved transportation between outlying areas and employment centers.

Since the bay crossing alternatives are being proposed at a time and in a location where the economic pressures for growth are very strong, it is unlikely that any of the Alternatives could induce growth on a regional scale over what is already expected to occur. *Projections 90* indicate that the conditions supporting growth, and hence the largest amounts of growth, will occur in Santa Clara, eastern Alameda, eastern Contra Costa and Solano Counties. None of the Alternatives will provide significant new transportation capacities to or from these areas.

All of the Alternatives would, as a result of their location, tend to reinforce the existing urban patterns of development and location of metropolitan centers in the East and West Bay. By allocating major capital investments for transportation improvements to the existing urbanized centers, they would reduce the availability of capital for new transportation investments in outlying areas. Indirectly, therefore, any of the bay crossing alternatives could have a regional effect on the location of future growth, supporting trends toward infill and intensification while potentially

---

[1] Association of Bay Area Governments, *Projections 90*, December, 1989, p. 55.

constraining the rate of development at the urban fringe. Specific Alternatives, therefore, might affect the course of development in localized areas, especially near stations, termini and interchanges, and could have differing effects on local growth plans.

Alternative 1: Ferry System

The proposed Ferry System would, to a large extent, serve commuters already making trips on existing freeways or using BART and buses between the East Bay and, primarily, San Francisco. While the ferries could provide commuting alternatives and allow room for new travelers, the travel forecasting results indicate that they would increase transbay travel by only 5,000 person trips a day, out of over 5 million projected in 2010. While ferry ridership would be many times today's levels, the regional effect is small and the project is more likely to be categorized as congestion management than capacity expansion.

Ferry terminals could stimulate residential growth with the redevelopment of nearby lands. Multi-family residential projects have been built near the Larkspur Ferry Terminal. High density infill projects have also been completed near the Port of Richmond and in Vallejo and have been proposed in Albany and South San Francisco. Locations where a ferry terminal could help stimulate new residential development might include Benicia, Rodeo, Berkeley, Alameda, Bay Farm Island, South San Francisco, and San Leandro.

In some cases, the localized development opportunities could also threaten environmentally sensitive wetlands resources. This could occur in Benicia, Rodeo, San Leandro, the Oakland Airport, and possibly other sites.

Alternative 4: Interstate 380 to 238 Bridge

Alternative 4 would be a major new, high capacity link in the regional transportation network. As large a project as it is, however, is not likely to induce growth beyond the 15 percent increase in regional population projected to occur between 1990 and 2005. This is primarily because it would not serve any areas where significant, developable land resources are available. ABAG projections indicate that job growth over the next 15 years in both the Peninsula Corridor and the East Bay South/Silicon Valley North Corridors will greatly exceed the local growth in labor supply. While this Alternative would increase the mobility between East Bay and West Bay points, it would not improve the transportation connection between labor deficit areas and potential new residential development areas.

By connecting directly with existing freeway networks in the East and West Bay areas, Alternative 4 may provide a viable freeway alternative between areas of high residential growth in eastern Alameda and Contra Costa Counties and San Francisco, a high job growth area. The travel forecasts indicate that 64 percent of the origins of users of the new bridge would be in western Alameda County while 11 percent would be in eastern Alameda County. This would indicate that while Alternative 4 would increase mobility between the West Bay and eastern Alameda County, the travel distance is so great that it is unlikely to induce an extra measure of growth over what is currently projected.

Alternative 4 would increase development pressure, probably for high density residential and some commercial development in locations along the I-238 corridor from the vicinity of San Leandro/San Lorenzo and Hayward to Castro Valley, and along the I-380 and Route 101 corridors in the mid-Peninsula area. However, little land is available for development or redevelopment in these locations, and most projects would probably be small and the pace of development slow. While some areas of open land may appear to be available along the bayfront, recent proposals, particularly in San Leandro and Hayward that have involved the filling of diked former baylands, have been rigorously opposed. This opposition can be expected to continue.

Alternative 6: BART Airport Connection

A BART connection between the two major airports would be mostly responsive to trends toward increasing mobility of the people of the Bay Area and of the country in general. Air traffic at both airports is projected to increase significantly in the coming decades, and both airports are developing expansion plans. This Alternative would fit into a specialized niche, accommodating improved access to the regional airports and probably intensifying their growth rates, possibly at the expense of other facilities such as the San Jose and Concord Airports. It would play almost no direct role in directing the intensity, location, or rate of regional economic and population growth.

Indirectly, however, if it were to become a key ingredient in the expansion of both airports and of their ability to increase their market shares of national and international flights, then it would have an effect on the growth of the regional economy.

Alternative 8: Transbay Tube

This Alternative would provide redundancy and an increase in capacity of the existing BART transbay link. It would reinforce existing patterns of commuting and residential/job locations. Like the original BART system, its effect on the growth of the regional economy, if any, would be overshadowed by other factors. It would perpetuate existing trends toward intense office development in downtown San Francisco and could hasten the predicted, but slow developing, intensification of employment in downtown Oakland, Walnut Creek, Concord, and other city centers with BART stations. Like the Ferry System Alternative, a new BART tube would also be responsive to demands for new efforts at congestion management.

Alternative 11: Inter-City Railroad Tunnel

A transbay inner-city railroad tunnel would provide new options for passengers and goods movement across the Bay. Its direct effects on localized and regional growth would be limited. Like the BART tube between the airports, this Alternative would focus more on the needs of a specialized transportation niche than on overall regional transportation demands. It would support the growth of waterborne transport and the international role of the Ports of Oakland and San Francisco. Indirectly, of course, their success could affect the overall regional economy.

Directly, however, this alternative would have little impact on regional growth and also minimal effect on land uses near its termini. The land uses in the Port of San Francisco and proposed in the Mission Bay Plan would probably be little affected if this alternative were selected. Similarly, it would reinforce the existing rail and seaport facilities at the terminus in the Port of Oakland.

6. COST REPORT

SECTION 6
COST REPORT

The purpose of this chapter is to define the capital and operating costs associated with each of the study alternatives. This report specifically addresses the final set of five "build" alternatives defined by the Technical and Advisory Committees and subsequently approved by the Policy Committee.

The chapter includes a summary of the unit costs used in the cost analysis and the associated data sources, as well as extended total cost for each "build" alternative.[1]

Details of the capital costs by segment for each alternative are provided in Appendix C.

6.1 DESCRIPTION OF COST METHODOLOGY

The following section presents an outline of the cost methodology proposed for the preparation of the capital and operating cost analysis. This includes a description of data sources for unit capital costs, the suggested composite unit capital costs, and suggested operating cost factors.

Sources of Data for Unit Costs

The following section outlines the suggested composite unit costs for application in developing the cost assessment. These construction costs are based on information taken from various recent cost reports and bids for comparable transportation projects on the west coast. A description of the sources that were used to generate the composite unit costs is provided below.

---

[1] Capital costs are also provided for the downscaled, five-route ferry system alternative (Alternative 1, Revised) and for a four-lane highway bridge without and with BART (Alt. 4, Revised, Phases I and II).

1. Bay Area Rapid Transit District

   a. Pittsburg-Antioch Corridor AA/DEIS/EIR Capital Cost Methodology Report, December, 1987.

   b. Dublin-Pleasanton Extension Capital Cost Methodology, May, 1989.

   c. BART System Performance Data, FY 81/82 through FY 88/89.

2. State of California; Business, Transportation and Housing Agency, Department of Transportation (Caltrans), Contract Cost Data for the Year 1989.

3. Metropolitan Transportation Commission

   a. Fremont-South Bay AA/DEIS/EIR Capital Cost Methodology Report, August, 1987.

   b. Peninsula Commute Service: San Francisco Downtown Station Relocation Capital Cost Estimating Methodology and Results, December, 1989.

   c. Intercity Rail Corridor Upgrade Study, Summary Report -- Phase 1, October 31, 1989.

   d. Tasman Corridor Alternatives Analysis Capital Cost Methodology Report, February, 1990.

   e. High-Speed Water Transit Study for the San Francisco Bay Area, April, 1985.

Composite Unit Costs

The purpose of this section is to provide actual unit costs or a range of unit costs for application in the development of capital cost estimates for each of the alternatives. The unit costs that are described cover civil/structural, trackwork, rail station facilities, and ferry facilities. All unit costs presented are based on total constructed values including contractor's overhead and expenses and are designed to reflect current 1990 pricing levels.

Civil/Structural

The unit costs for civil/structural facilities are described below.

Item	Unit Cost
Main Bridge Span	
Vehicle	$ 13 - 15 million per lane mile
Trestle Bridge	
Vehicle	$ 6 - 7.5 million per lane mile
Toll Facility	$ 2 - 5 million per facility
Freeway	
At-grade Freeway	$ 0.3 - 0.5 million per lane mile
Aerial Freeway	$ 4 - 6 million per lane mile
Freeway Interchanges	
Local Interchange	$ 15 - 25 million per facility
Freeway-to-Freeway (Modify)	$ 25 - 100 million per facility
Freeway-to-Freeway (New)	$ 100 - 150 million per facility

Trackwork

The unit costs for trackwork, which includes both BART and heavy rail construction, are described below.

Item	Unit Cost
Main Bridge Span	
BART (double track)	$ 35 - 40 million per mile
Trestle Bridge	
BART (double track)	$ 20 - 32 million per mile
BART	
Aerial (double track)	$ 40 - 60 million per mile
Suburban Subway (double track)	$ 70 - 100 million per mile
Urban Subway (double track)	$ 170 - 210 million per mile
Transbay Tube (double track)	$ 160 - 170 million per mile
Fly-Over (single track)	$ 20 - 30 million per mile
At-Grade	$ 30 - 40 million per mile
Railroad (standard)	
At-Grade (double track)	$ 4 - 6 million per mile
Transbay Tube (double track)	$ 190 - 200 million per mile

Rail Station Facilities

The unit costs for rail station facilities are described below.

Item	Unit Cost
BART	
Aerial Station (double track)	$ 5 - 7 million per station
Subway Station (double track)	$ 25 - 45 million per station
Railroad Station	
Subway Station (double track)	$ 25 - 30 million per station
Parking Facilities	
At-Grade	$ 2,500 per stall
Structure	$ 10,000 per stall

Ferry Facilities

The unit costs for ferry facilities are described below.

Item	Unit Cost
Terminal Modifications/Installations	
Existing	$ 10 - 20 million per terminal
New	$ 20 - 25 million per terminal
Ferry Boat (catamaran)	$ 2 - 3 million per boat
Access Roads	$ 0.3 - 0.5 million per lane mile
Parking Facilities	
At-Grade	$ 2,500 per stall
Structure	$ 10,000 per stall

Operating Cost Factors

The following cost factors are provided as an indicator of the relative cost to operate new BART, railroad, and ferry routes. The costs for each system are based on the unit cost per revenue hour for each system vehicle.

System	Cost Factor
BART	$ 145 per revenue hour per *vehicle*
High-Speed Ferry	$ 400 - 550 per revenue hour per boat
Railroad (passenger)	$ 950 per revenue hour per *train*

The operating and maintenance costs for a vehicle bridge as identified in Alternative 4 are based on annual costs experienced by Caltrans for the existing Hayward-San Mateo Bridge. This bridge, which is an orthotropic design similar to the one identified for Alternative 4, has an annual operating and maintenance cost of approximately $2.5 million. The majority of these costs are tied to the maintenance of the main span structure rather than the trestle bridge approaches.

While the length of the bridge identified in Alternative 4 is measurably greater than the current Hayward-San Mateo Bridge, the main span structure of the two bridges are of equivalent length. The difference in length is due to the longer trestle bridge sections on both the West Bay and East Bay approaches to the main span for Alternative 4. Since the difference in length is primarily due to the longer trestle bridge sections which comprise a smaller proportion of the overall annual costs, the annual operating and maintenance costs are expected to be only slightly higher than those for the existing bridge. The projected bridge costs for Alternative 4 range from $2.8 to $3.0 million per year.

The operating costs identified for BART are based on the cost per BART vehicle rather than the cost per BART train, as is cited for Passenger Railroad service. The operating cost of $145 per revenue hour per BART vehicle is equivalent to approximately $1,050 per revenue hour per BART train (e.g., average of approximately seven vehicles per train in BART system). By comparison, the BART operating cost is therefore higher, on a "per train basis", than the Passenger Railroad system.

The operating cost assessment for each of the three systems (BART, ferry, and Passenger Railroad service) is based on the cost to provide weekday service throughout the year. The analysis assumes an operating schedule of approximately 12 to 14 hours per day for each system to provide a comparable estimate of operating costs.

6.2 SUMMARY OF STUDY ALTERNATIVE COSTS

The following section presents a summary of the total capital and operating costs for each of the five study alternatives. A description of the individual segment capital costs for each alternative is provided in Appendix C.

Summary of Overall Capital Costs

The total capital costs for the five alternatives range from a low of $570 million (Alternative 1) to a high of approximately $3.9 billion (Alternative 6). These capital construction cost estimates are provided in 1990 dollars. The cost information provided in Appendix C includes a range in costs for each segment. This range provides a representation of the potential low and high end costs

that are typically associated with each type of construction. A summary of the range in capital costs for each alternative is provided in Table 6-1.

Additional cost data is provided on "scaled down" versions of two of the five alternatives developed on the basis of travel forecasts provided in Chapter 3. This includes Alternative 1 (High-Speed Ferry) and Alternative 4 (Interstate 380 to 238 Bridge). The Revised Alternative 1 scenario includes the five ferry routes with the highest patronage and the route connecting the San Francisco and Oakland Airports. Each of the ferry routes would operate at 15 minute headways, as was originally assumed for all 15 routes. The Revised Alternative 1 includes enhanced ferry service from San Francisco to Vallejo, Rodeo, Richmond, a combined Oakland/Alameda route, and Bay Farm Island. The Revised Alternative 4 scenario involves costing the bridge in two separate phases. The first phase would involve construction of a bridge with four mixed-flow travel lanes (i.e., two in each direction) with an upgraded foundation to support subsequent construction of two BART tracks. Phase 2 of the Revised Alternative 4 scenario includes the construction of two BART tracks.

TABLE 6-1

SUMMARY OF CAPITAL COSTS

Alternative	Description	Total Capital Cost Range
1	High-Speed Ferry	$570 - 915 million
1, Revised	**High-Speed Ferry (six routes)**	**$177 - 314 million**
4	Interstate 380 to 238 Bridge BART Costs Highway & Bridge Costs Right-of-Way Costs	**$2,770 - 3,391 million** **($822 - 1,106 million)** **($1,521 - 1,858 million)** ($427 million)
4, Revised	**Phase I: Bridge (four-lanes)**[1] **Phase II: Bridge & BART**	**$1,281 - 1,485 million** **$1,878 - 2,304 million**
6	BART Airport Connection	$3,432 - 3,943 million
8	BART Transbay Tube Connection	$2,169 - 2,594 million
11	Inter-City Railroad Connection	$1,518 - 1,601 million

[1] The costs for Alternative 4, Revised (Interstate 380 to 238 Bridge) do not include $130 - $160 million for a pedestrian/bicycle facility on the bridge. The inclusion of these costs would result in a total Phase I cost of $1,411 - $1,645 million and a total Phase II cost of $2,008 - $2,464 million.

The capital costs cited above for each of the alternatives include the construction of fixed highway and transit facilities, right-of-way costs, and transit vehicle costs. The right-of-way costs included are summarized below for each of the five study alternatives:

- Alternative 1: $ 24 million
- Alternative 4: $ 427 million
- Alternative 6: $ 147 million
- Alternative 8: $ 138 million
- Alternative 11: $ 57 million

The high-speed ferry option (Alternative 1) is the least costly of the five options, while a mid-bay BART tube connecting the San Francisco and Oakland Airports would be the most costly. The two primary components of the high-speed ferry system are the cost of ferry boat acquisition and terminal improvements. The most costly option, which is associated with the BART Airport Connection, is due to the high cost of constructing an 11-mile BART tube under the Bay.

The railroad tunnel (Alternative 11) is the second least costly option in comparison to the high-speed ferry option. The greatest share of the total capital cost for Alternative 11, which ranges from $1.5 to $1.6 billion, is due to the construction of the rail tunnel. As shown above, the railroad tunnel would also have minimal right-of-way requirements when compared to the other alternatives.

The capital costs for the parallel transbay BART tube (Alternative 8) fall roughly mid-way between the least and most costly alternatives. The capital cost for this option ranges between $2.2 billion and $2.6 billion. The greatest share of the total capital cost for Alternative 8 is due both to the construction of a new BART tube and to the construction of subway BART lines in downtown San Francisco and Oakland.

The capital cost for the bridge option (Alternative 4) of $2.8 to $3.4 billion includes both highway, bridge, and BART costs. The BART costs represent approximately 35 percent of the total cost.

The capital cost estimate for this option does not include the provision of bicycle/pedestrian lanes on the bridge spans. The cost for providing a bicycle/pedestrian facility is approximately $130 to $160 million. The bridge construction cost also does not include the cost of providing a connection to planned bike lane facilities in the East Bay and West Bay, which would be required to facilitate a connection to the regional trail system; however, the cost for the bridge bicycle/pedestrian facility would include a connection to shoreline trails.

Alternative 4A, which represents a southerly alignment option for Alternative 4, would be slightly more costly based on a longer trestle bridge segment in the East Bay and higher right-of-way costs for commercial land acquisition. The cost for Alternative 4A would be approximately $74 to $77 million more than the capital cost for Alternative 4. This represents a difference of 2-3 percent of the total capital cost. It should be noted that if Alternative 4 is studied in more detail in the future, many different alignments may be examined, including the ones in this report.

The Phase 1 capital cost for Revised Alternative 4 (i.e., four-lane bridge only) ranges from $1.3 to $1.5 billion. This includes a four-lane highway facility with an upgraded foundation to support the construction of two additional lanes for transit purposes. The Phase 2 capital costs for Revised Alternative 4 would range from $1.9 to 2.3 billion, which includes both a four-lane bridge and a new BART crossing in the median. The incremental cost of constructing BART in Phase 2 ranges from $0.6 to $0.8 billion.

Summary of Overall Operating Costs

The following costs are provided to illustrate the approximate annual costs of operating and maintaining each of the transportation systems included in the five final alternatives. This includes the cost of operating transit vehicles (ferry boats, BART vehicles, and railroad train sets), maintaining transit stations (where not included in the overall operating costs, as with BART), and maintaining the vehicle bridge. These operating costs are provided in 1990 dollars.

The overall operating cost ranges from a low of $20 million per year for rail service (Alternative 11) to a high of approximately $118 million per year for high-speed ferry service (Alternative 1). A summary of the operating costs for each alternative is provided in Table 6-2. Additional operating cost information is provided in Appendix C.

TABLE 6-2
SUMMARY OF OPERATING COSTS

Alternative	Description	Total Operating Cost Range
1	High-Speed Ferry	$87 - 118 million/year
4	Interstate 380 to 238 Bridge BART Costs Highway & Bridge Costs	$30 million/year ($27 million/year) ($3 million/year)
6	BART Airport Connection	$27 million/year
8	BART Transbay Tube Connection	$27 million/year
11	Inter-City Railroad Connection	$20 million/year

Implementation Schedule

The projected implementation schedule for each of the five study alternatives is shown in Appendix C. The schedule illustrates the relative amount of time required for right-of-way acquisition, vehicle acquisition, and construction. In addition, Table C-9 provides a summary of the apportionment of these costs by year.

7. FINANCIAL REPORT

SECTION 7
FINANCIAL REPORT

7.1 INTRODUCTION AND MAJOR FINDINGS

The purpose for the Bay Crossing Study Financial Analysis is to determine the financial feasibility of constructing the five bay crossings alternatives under study. As agreed to by the Advisory and Policy Committees, this analysis focuses on toll revenues as the primary financing mechanism. The committees asked that three different toll increase scenarios be examined: $1, $2, and $4. Toll increases were assumed for all three bridges in the Southern Bridge group (Bay, San Mateo, and Dumbarton Bridges). The toll structure on the new highway bridge crossing (Alternative 4) is assumed to have the same toll structure as the other bridges in the Southern Bridge group.

In several situations, toll revenues were not sufficient to fully fund the construction cost of an alternative. For these situations, we identify the shortfall and discuss other funding sources that might be available to fully fund an alternative.

In addition to examining the three toll increase scenarios above, we undertook a breakeven analysis that shows the toll structure necessary to finance each alternative. This will allow the reader to see, for example, the toll structure necessary to finance an alternative, given a specific toll crossing forecast. Conversely, the reader can see the number of crossings that would be needed to generate toll revenues sufficient to fully fund each alternative, given a specific toll structure.

Finally, we examined the potential for private financing of the new toll bridge.

Assumptions

In order to develop a realistic model that simulates toll revenue flows over a 30 to 40 year time period, we had to make assumptions on growth rates, timing of toll increases, etc. These assumptions are listed in Appendix D of this report.

Appropriateness of Using Toll Revenues

Toll revenues have historically been used to finance construction and improvements on the Bay Area's bridges. This has not been the situation for mass transit funding in the Bay Area or California. While toll revenues play an important part in the region's mass transit financing, other financing sources (federal and state mass transit funding) have been the predominate source for funding construction of the Bay Area's transit system. Our focus on toll revenue financing for the Bay Crossing Study is not intended to represent a change in this practice. However, traditional sources of mass transit funding have not kept pace with mass transit financing needs, and are already being used to the maximum extent possible for current transit needs. Non-traditional sources of funding (local sales taxes, state rail bonds, etc,) are playing a larger role in mass transit financing. Further, the concept of deriving the funding for a public investment from the population that benefits is one that is widely accepted by public finance experts. Toll financing for a new bay crossing meets this test since the alternatives that we are examining in the Bay Crossing Study provide a benefit to all persons using the Bay Area's bridges. For these reasons, we believe toll revenue financing is an appropriate mechanism for providing the major source of financing for the highway bridge crossing (Alternative 4) as well as the rail mass transit alternatives in our study.

Contents

The following sections are in this chapter:

- Section 7.2: Toll Financing for Alternatives 1, 6, 8, and 11
- Section 7.3: Toll Financing for Alternative 4
- Section 7.4: Private Sector Financing
- Section 7.5: Breakeven Analysis
- Section 7.6: Alternative (Non-Toll) Funding Sources
- Section 7.7: Financial Impact of New Bay Crossing on Regional Funding Needs
- Technical Appendix (Appendix D)

Major Findings from Financial Analysis

- The maximum financial capacity provided by a $1, $2, and $4 Year 2000 toll increase on the Southern Bridge group is (1990 dollars):

$1 increase	$ 360.3 million
$2 increase	$ 787.8 million
$4 increase	$ 1,536.7 million

  Financial capacity is defined as the maximum bonding capacity in the Year 2000, plus (or minus) any financial reserve balance.

- The following surpluses/(deficits) remain after applying the financial capacity created from a $4 toll increase toward each alternative's design/construction cost (million of 1990 dollars):

Alternative 1	$ 778.8
Alternative 1 (Revised)	1,275.8
Alternative 4 (Original)	(1,052.8)
Alternative 4 (Phase 1)	153.7
Alternative 4 (Phase 2)	(200.5)
Alternative 6	(2,166.2)
Alternative 8	(860.2)
Alternative 11	(38.2)

- Options other than toll financing exist to finance the deficits shown above. For the rail crossings (Alternatives 6, 8, and 11), Federal UMTA Section 3 and/or State Transit Capital Improvement funds have traditionally been used to partially fund new rail extensions, and may be available for a new rail crossing. For Alternative 4 (the new highway bridge), there is the potential for Federal Highway funding, State-Local partnership funding, and State Flexible Congestion Relief funding.

- We determined the toll structure that would allow us to fully fund each alternative. This "breakeven" toll structure assumes that tolls would be continuously increased in order to keep up with inflation. By the Year 2000, the equivalent 1990 $1 toll would equal $1.63. Then in the Year 2000 there would be a one-time toll increase sufficient to generate the financial capacity to fully fund the alternative. The results are summarized in Table 7-5.

- The cash flow generated exclusively on the new bridge crossing (Alternative 4) from a $10 toll increase is not sufficient to support private financing of the bridge's construction.

- A $4 real toll increase (above the rate of inflation) will reduce transbay vehicle demand by 6.5 to 13.2 percent. Higher toll increases could be expected to have more significant impacts on transbay vehicle demand.

- The financing needed to construct a new rail or highway crossing will impair the ability of the region to finance other important transit/highway improvements. We have identified a minimum of $4.6 billion in other transportation projects that could compete with a bay crossing alternative for toll revenues and other transportation funds.

7.2 TOLL FINANCING FOR ALTERNATIVES 1, 6, 8, and 11

Alternative 1 (upgraded ferry system), 6 (new BART transbay tube), 8 (BART tube between the airports) and 11 (inter-city rail under the Bay) are mass transit alternatives for improving transportation across the Bay. None of these alternatives include the construction of a new highway bridge. Therefore, the three existing bridges in the Southern Bridge group would be the sole source of toll revenues for constructing these alternatives.

Given the assumptions noted in Appendix D, we examined the maximum financial capacity that would be created from $1, $2, and $4 dollar toll increases in the Year 2000 on the three bridges in the Southern Bridge group. The results are summarized below and compared with the total construction costs figures developed in the Cost Report. (All figures are in millions of 1990 dollars. Capital costs are the approximate average of the high and low cost figures from the Cost Report):

TABLE 7-1
TOTAL REVENUE $1 TOLL INCREASE = $360.3 MILLION

	Capital Cost	Surplus/(Deficit)
Alt. 1	742.0	(382.2)
Alt. 1 (Revised)	246.0	114.8
Alt. 6	3,687.5	(3,327.2)
Alt. 8	2,381.5	(2,021.2)
Alt. 11	1,559.5	(1,199.2)

Table 7-1 shows that a $1 dollar toll increase in the Year 2000 creates a maximum financial capacity of $360.3 million, leaving a funding deficit for each alternative except Alternative 1, revised.

Table 7-2 shows the same information under a $2 toll increase assumption:

TABLE 7-2
TOTAL REVENUE $2 TOLL INCREASE = $787.8 MILLION

	Capital Cost	Surplus/(Deficit)
Alt. 1	742.5	45.3
Alt. 1 (Revised)	246.0	542.3
Alt. 6	3,687.5	(2,899.7)
Alt. 8	2,381.5	(1,593.7)
Alt. 11	1,559.5	(771.7)

Under a $2 toll increase, $788 million in financial capacity is available for constructing these alternatives allowing Alternative 1's capital costs to be fully funded. Deficits for other alternatives are reduced.

Finally the $4 toll increase is summarized below:

TABLE 7-3
TOTAL REVENUE $4 TOLL INCREASE = $1,521.3 MILLION

	Capital Cost	Surplus/(Deficit)
Alt. 1	742.5	778.8
Alt. 1 (Revised)	246.0	1,275.8
Alt. 6	3,687.5	(2,166.2)
Alt. 8	2,381.5	(860.2)
Alt. 11	1,559.5	(38.2)

Under a $4 dollar toll increase, capital costs for Alternative 1 are fully funded. Other alternatives show varying unfunded deficits.

Conclusion

Of the four non-highway alternatives above, as expected, Alternative 1 appears to be the most financial feasible. This is due to its much lower capital cost relative to the other alternatives. However, unlike the other mass transit alternatives, a significant part of the costs for Alternative 1 involve operations (estimated at $87 to $118 million per year). The surplus bonding capacity indicated in the above tables for Alternative 1 may be needed to help offset annual operating costs. Alternative 6, due to its much higher capital cost has the largest funding deficit. Even at a $4 toll increase, Alternative 6 shows a $2.2 billion capital funding deficit.

7.3 TOLL FINANCING FOR ALTERNATIVE 4

Alternative 4 is a new bridge highway crossing between I-238 in the East Bay and I-380 in the West Bay. A BART extension is in the median of the bridge. In this study, we examined three alternatives:

Alt. 4 Original:	Eight-lane bridge with BART in median. Total capital cost is estimated at $3.1 billion.
Alt. 4 Phase 1 (Alt.4R1):	A smaller (four-lane) bridge with the potential for expansion in the future. Capital cost is estimated at $1.4 billion.
Alt. 4 Phase 2 (Alt.4R2):	Phase 1 plus BART in the median. Capital cost is $2.1 billion.

In comparison to travel forecasts under the Base Case (Highway/Transit blend as defined in the Regional Transit Plan), MTC travel forecasts do not show that Alternative 4 increases total highway bay crossings in the Year 2010. What appears to be occurring is largely a shifting of travel between bridges. Therefore, the maximum financial capacity in the Southern Bridge group with the inclusion of this new bridge is not significantly different than the non-bridge scenarios discussed in Section I.

For purposes of analyzing the financial feasibility of this alternative, we are assuming that the BART element of Alternative 4 and 4-Phase 2 would be 50 percent funded with federal funds. This ratio of federal funding is a reasonable assumption for federal funding of a major rail extension projects and would require an annual federal funding commitment similar to what is programmed in MTC's New Rail Starts and Extensions program.

Table 7-4 summarizes these assumptions and shows the total toll financing needed for Alternative 4. Each cell in Table 7-4 shows the net result after applying the financial capacity created from a toll increase to the capital costs (with the assumption that BART costs are 50 percent funded from non-toll revenues) for Alternative 4. The capital costs are shown above. The following is the financial capacity created from the respective toll increases in the Year 2000 (1990 dollars):

$1 toll increase .... $ 350.7 million
$2 toll increase .... $ 781.7 million
$4 toll increase .... $1,536.7 million

TABLE 7-4
CAPITAL COST SURPLUS/(DEFICITS)

	Alt.4	Alt.4R1	Alt.4R2
Toll Increase			
$1	(2,238.8)	(1,032.3)	(1,386.5)
$2	(1,807.8)	(601.3)	(955.5)
$4	(1,052.8)	153.7	(200.5)

Table 7-4 shows that after a $4 toll increase, Alternative 4 will need $1 billion in additional financing in order to fully fund construction costs. Alternative 4-Phase 1 (Alt.4R1) is fully funded with a $4 toll increase and Alternative 4-Phase 2 (Alt.4R2) needs an additional $200 million in financing after applying the proceeds of a $4 toll increase.

7.4 PRIVATE SECTOR FINANCING FOR ALTERNATIVE 4

The Advisory and Policy Committees had requested an examination of the potential for private financing for construction of the bridge alternative (Alternative 4 minus the costs of BART). Our approach was to determine if the cash flows generated exclusively on the new bridge from the highest toll increase we examined ($10 toll increase effective in the Year 2000) would be sufficient to compensate investors who may be interested in financing the bridge's construction. We did this by discounting (derived the present value) of both costs and revenues at a discount rate that

represents a private sector opportunity cost of capital appropriate for a project of this type (13 percent -- see Technical Appendix D). If the private sector is to finance this project, the present value of the future stream of revenues must be equal to or greater than the present value of the project's costs. In other words, the Net Present Value (NPV) must be zero or positive.

One important assumption that we should highlight is that our analysis implicitly assumes that all other bridges in the Southern Bridge group would have the same toll structure as the new bridge, an $11 dollar toll. If this were not the case, traffic volumes on the new bridge would be far less than our current projections since people would divert to adjacent bridges to avoid the high toll.

Our analysis shows that the NPV for the bridge project is strongly negative as shown below (figures in millions):

Alt. 4: NPV (Assuming low-range bridge costs)	-$1,604.0
Alt. 4: NPV (Assuming high-range costs)	-$1,915.3
Alt. 4 (Phase 1): NPV	-$1,079.6

Conclusion

The amount of revenue generated from a $10 toll increase in the Year 2000 would not be sufficient to generate a return that would be attractive to private investors, assuming 100 percent private financing of the entire bridge project. This applies even to our lower cost Alternative 4-Phase 1. The results are not surprising given the fact that no firm selected a new bridge for the recent AB680 privatization program, although it was examined for feasibility by a number of firms. Costs would either have to be reduced to a level that is likely infeasible, or revenues dramatically increased.

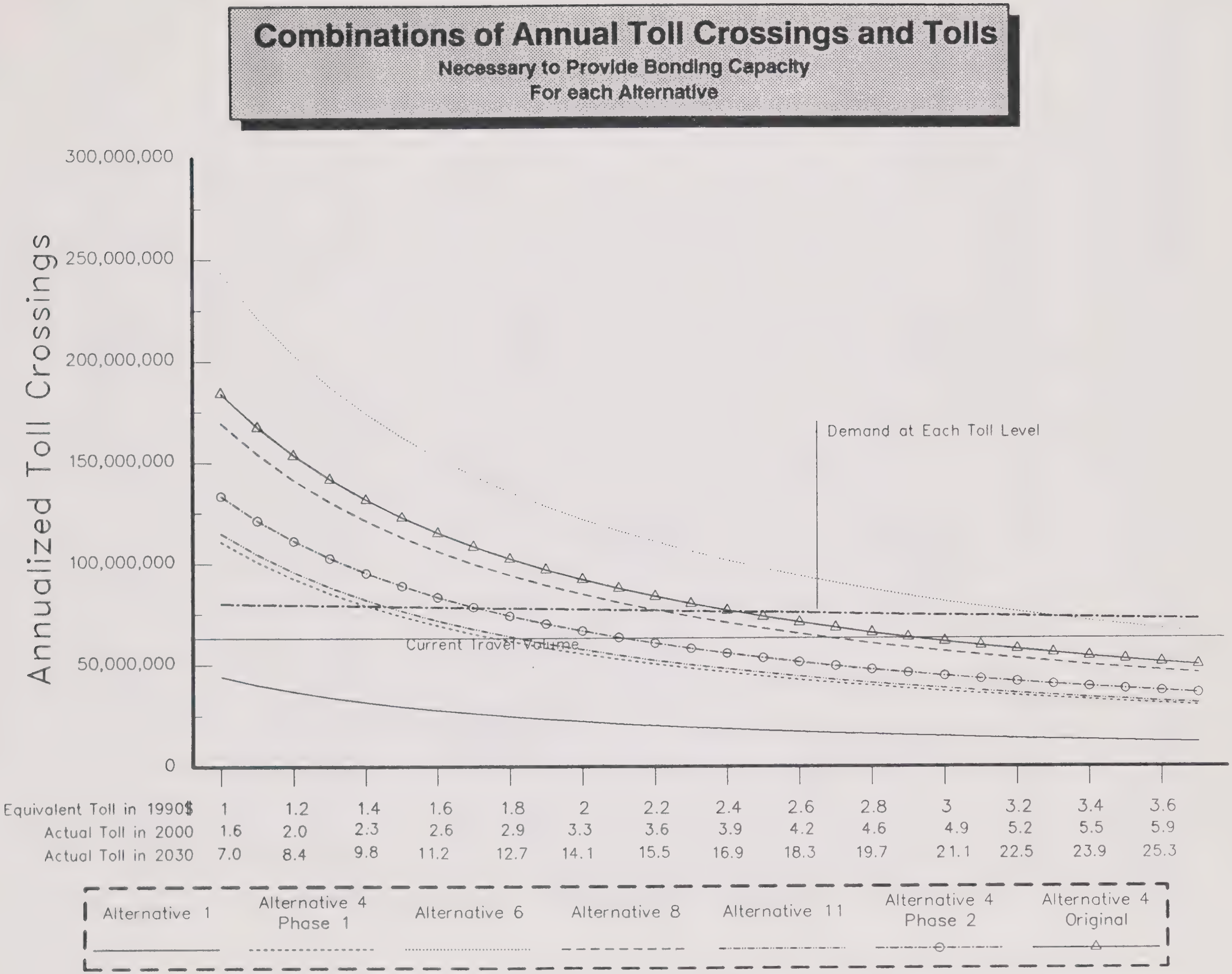
7.5 BREAKEVEN ANALYSIS

We undertook an analysis to determine the number of toll crossings and the toll structure necessary to fully fund each alternative. Our breakeven analysis assumed that tolls would be continuously increased--starting in 1992--in order to keep up with inflation. Then in the Year

2000, there would be a one-time "real" increase (increase that exceeds the inflation rate). From the Year 2000 on we assume that tolls would continue to be increased to maintain parity with inflation. We believe that this represents a more realistic toll increase scenario than one that assumes a massive one-time only toll increase in the Year 2000. It should be noted that this toll increase scenario is different than what is assumed in the previous discussion. The $1, $2, and $4 toll increases previously discussed assume a one-time only toll increase in the Year 2000.

The results of our analysis are illustrated in Figure 7-1.

What Figure 7-1 shows is the combination of tolls and toll crossings necessary to provide the financial capacity that is sufficient to fully fund each alternative. Each curved line pertains to one of the Study's alternatives, and traces out the combination of tolls and crossings that fully fund each alternative. We have included a travel demand forecast line that is derived from the Year 2010 forecasts made for this study. This line represents an annualized average of our forecast given a specific toll rate. The travel demand line can be used to determine specific breakeven points. For example, the most expensive alternative is the BART tube between the airports (Alternative 6). Figure 7-1 shows that to fully fund this alternative given the travel demand forecast, tolls would have to be increased -- beginning in 1992 -- so that they maintain parity with inflation. In the Year 2000, a one-time toll increase of $3.80 is made leaving the toll structure at $5.40 in the Year 2000. Tolls would then have to continue to be increased to keep up with inflation. In order to maintain parity with inflation, by the Year 2030 our $5.40 toll would have to be increased to $23.20.


Combinations of Annual Toll Crossings and Tolls
Necessary to Provide Bonding Capacity
For each Alternative
Annualized Toll Crossings
300,000,000
250,000,000
200,000,000
150,000,000
100,000,000
50,000,000
0
Demand at Each Toll Level
Current Travel Volume
Equivalent Toll in 1990$ 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6
Actual Toll in 2000 1.6 2.0 2.3 2.6 2.9 3.3 3.6 3.9 4.2 4.6 4.9 5.2 5.5 5.9
Actual Toll in 2030 7.0 8.4 9.8 11.2 12.7 14.1 15.5 16.9 18.3 19.7 21.1 22.5 23.9 25.3
Alternative 1
Alternative 4 Phase 1
Alternative 6
Alternative 8
Alternative 11
Alternative 4 Phase 2
Alternative 4 Original

Other breakeven points can be picked off from Figure 7-1 by determining the intersection between the MTC travel forecast line and the alternative curve. These are summarized in Table 7-5 below:

TABLE 7-5
BREAKEVEN POINTS

Alternative	Year 2000 Toll Rate (1990 dollars)	Year 2000 Toll Rate	Year 2030 Toll Rate
Alt. 1	$ 1.00	$ 1.55	$ 6.89
Alt. 1 Revised	(2)	(2)	(2)
Alt. 4(3)	$ 2.50	$ 4.07	$17.60
Alt. 4 (Phase 1)	$ 1.42	$ 2.32	$10.15
Alt. 4 (Phase 2)(3)	$ 1.75	$ 2.85	$17.87
Alt. 6	$ 3.31	$ 5.40	$23.20
Alt. 8	$ 2.20	$ 3.60	$15.50
Alt. 11	$ 1.45	$ 2.36	$10.21

(1) For this analysis, we used high-range cost estimates.
(2) Simply maintaining tolls with inflation will provide sufficient capacity to fully fund capital costs.
(3) Assumes 50 percent of BART costs would be funded using non-toll revenues sources.

The first column, the Year 2000 Toll Rate in 1990 dollars, shows the Year 2000 toll rate adjusted for inflation.

7.6 ALTERNATIVES TO TOLL FUNDING

Rail Crossing Alternatives

Since Alternative 1 appears to be financially feasible at a relatively low toll increase level, we will not address the prospects for non-toll funding for Alternative 1 in this report.

Alternatives 6, 8, and 11 all represent rail mass transit alternatives. Therefore, all would be eligible for the following federal and state rail funding programs:

- Federal New Rail Starts and Extensions funds (Section 3 of the Urban Mass Transportation Act)

- State Transit Capital Improvement Funding (State TCI)

These two funding sources have historically been the primary non-local funding source for large rail transit projects in the region. Both sources are discretionary. Federal funds are allocated by the Urban Mass Transit Administration (UMTA) and State TCI funds are allocated by the California Transportation Commission (CTC). It is not possible to project the level of state and federal funding that may be available for a particular project when and if a bay crossing alternative is constructed. Rather than attempt a projection, we have identified potential federal and state funding demands that may be needed, and compare this need with estimated federal and State TCI funding needs for the MTC's New Rail Starts and Extensions program. MTC's New Rail Starts and Extension program is similar in magnitude to the rail alternatives in the Bay Crossing Study. If a bay crossing alternative were selected and implemented, it is likely that construction would take place sometime after the Year 2000, approximately when the New Rail Starts program is scheduled to be completed. Federal and state funding needs for MTC's New Rail Starts program can be considered ambitious; therefore, a comparison of federal/state funding needs for bay crossing alternatives with the New Rail Starts and Extensions program allows us to see if potential funding needs for a new bay crossing are realistic.

For MTC's New Rail Starts and Extensions program over the next ten years, total federal funding is programmed at $757 million (1990 dollars). For State TCI funding it is $260 million.

For the rail alternatives in the Bay Crossing Study, Table 7-6 shows the unfunded deficits remaining after applying toll funds available from a $4 toll increase. We have assumed that the remaining deficit would be funded 50/50 between federal and state funding, which is a conventional funding mix used in many major rail extension projects (millions of 1990 dollars):

TABLE 7-6
ESTIMATES/FEDERAL/STATE FUNDING NEEDED BETWEEN 2000 - 2010

Alternative	Federal Funding	State Funding
Alternative 6	**$ 1,083.1**	**$ 1,083.1**
Alternative 8	$ 430.1	**$ 430.1**
Alternative 11	$ 19.1	$ 19.1

Figures in bold print identify potential federal and state funding needs that exceed current New Rail Starts funding targets.

Conclusion

UMTA Section 3 Federal funds and State TCI funds are alternative funding sources for financing the capital needs for bay crossing rail alternatives. However, after applying toll revenues from a $4 toll increase, potential federal and state funding needs for Alternative 6 exceed MTC's current target funding levels for regional rail projects. State funding for Alternative 8 also exceeds target levels. Therefore, these alternatives will likely need to utilize other funding sources in addition to tolls, federal and state revenues, or toll increases in excess of $4 will have to be considered.

Public funds in addition to Federal Section 3 and State TCI may be available to fund construction of the mass transit alternatives in the Bay Crossing Study. For example, Congress authorized airports to levy passenger facility charges. It is possible that these charges, if levied by Oakland and San Francisco Airports, could be used to help finance Alternative 6. Other sources include local sales taxes, local property taxes, redevelopment fees, other types of user fees, air pollution

fees, etc. However, a meaningful forecast of these funding sources at the feasibility study stage is not possible and should only be attempted as part of a specific project funding plan. Further, these funding sources may be committed to other transportation projects.

Alternative Funding For New Highway Bridge (Alternative 4):

Based on our previous analysis, we showed that Alternative 4 will need between $2.5 billion in additional funding (assuming high cost and only a $1 toll increase) to $823 million (low cost, $4 toll increase). Funding deficits after applying revenues from a $4 toll increase for Alternative 4 Revised (Phase 1 and Phase 2) are substantially less or non-existent. There are several potential funding sources for this gap:

> Federal Funding: The Surface Transportation Act is scheduled to be reauthorized in 1991. The Federal Highway Administration is proposing a discretionary bridge program to Congress, and is also proposing to allow toll facilities to be funded up to 30 percent with federal grants. An earmarking of funds could be sought over several years for Alternative 4. This would require considerable political effort at the federal level, and would compete with other transportation needs.
>
> State-Local Partnership: This new program allows wholly locally-financed projects to qualify for a state match. Legislative authority could be sought to allow toll-funded projects to qualify for this program. However, there is little money available (less than $200 million statewide annually).
>
> Flexible Congestion Relief: The State FCR program could be used to fund approaches to the bridge, although the approach projects would have to compete with other highway and transit projects within Alameda and San Mateo Counties for a share of the respective county minimum. For example, the cost of Alternative 4 includes a $100 million interchange between the new bridge and I-880; some of this cost is potentially eligible for the State FCR program. However, each county's Congestion Management Agency would have to give these projects a high enough priority to be funded, potentially displacing other county transportation projects.

7.7 FINANCIAL IMPACT OF NEW BAY CROSSING ON REGIONAL FUNDING NEEDS

The focus of the Financial Analysis is on the use of toll revenues to fund the capital costs for a new bay crossing; whether it be a rail alternative or a new highway bridge. However, toll revenues may also be necessary for other important regional highway and transit needs in the region. This section outlines these other needs and discusses the potential conflict between toll revenues for a new bay crossing and toll revenues for other regional transportation needs.

We have already noted MTC's New Rail Starts program, which is a $2.8 billion program that is scheduled to last until the Year 2000. This program currently shows a $145 million funding shortfall (1990 dollars). Beyond the ten year horizon, many agencies have submitted other rail extension projects for consideration in the New Rail Starts program. These projects are currently being programmed for Planning Development in MTC's New Rail Starts program and in most cases, are largely unfunded. Table 7-7 lists some of the rail extension projects that are being considered in Alameda, San Mateo, San Francisco, and Santa Clara County:

TABLE 7-7
BAY AREA RAIL EXTENSION PROJECTS

Project	Cost (millions of 1990 dollars)
BART to San Jose (East Bay)	$ 1,800
BART from San Jose to Palo Alto	922
Dumbarton Rail Corridor	36
Oakland Airport Corridor	132
BART SFO to Santa Clara County	853
Muni Bayshore Corridor	294
Muni Geary Corridor	600
BART to Livermore	481
Unfunded Tier I Rail Extensions	145
TOTAL	$ 5,263

Toll revenues would not fund the entire amount shown above, but would likely play a significant part in MTC's financing plan, as would FCR revenues.

In addition to the above, there are other transit improvements that may be necessary, such as upgrades to the CalTrain system (electrification, new facilities, etc.) and financial assistance to

maintain existing bus and rail services (BART, CalTrain, A.C. Transit). Also many unfunded highway improvements exist. The key projects that may compete with a new bay crossing include improvements to I-880, I-580, I-80, I-238, and Route 24/13 in Alameda County, and improvements to Route 101 and I-280 in the West Bay. In addition to the projects above, significant funding will also be needed for seismic retrofitting of existing bridges in the Bay Area. It is clear that existing needs of the region will strain the region's financial capacity. MTC is now in the process of identifying these needs as part of its update of the Regional Transportation Plan.

Toll increases to finance a new bay crossing would not necessarily preclude toll increases for other needed transportation purposes. However, it is evident that at some point a ceiling is reached in which further toll increases are infeasible. Voters have voted to increase tolls for specific and identifiable transportation improvements. Further, because of inflation, the financial burden of any given toll structure erodes over time. A $5 dollar toll structure in the Year 2000 is equivalent to a $3.06 toll today. Therefore, there is no quantifiable way to say what toll structure, at what time period, represents the absolute ceiling.

Conclusion

There are other significant regional transportation needs in the Bay Crossing Study area that will need to make use of toll revenues as well as other transportation financing sources. We have identified over $5.26 billion in additional transportation projects that will be competing for funding over the next 20 years. The bay crossing would represent an additional need that would further stretch the financial capacity of the region. Implementation of a bay crossing alternative could delay implementation of other highway and rail transit projects by utilizing a significant amount of available transportation funding.

8. EVALUATION

SECTION 8
EVALUATION

8.1 INTRODUCTION

The evaluation of bay crossing travel alternatives takes into account five different subject areas:

- Travel System Performance
- Environmental and Socio/Economic Effects
- Cost Factors
- Financial Issues
- Cost Effectiveness

For each of these evaluation areas, graphical evaluation tables have been prepared in accordance with the agreed upon evaluation methodology. These figures have been supplemented with tables for quantitative measures.

The travel evaluation identifies the performance of each of the five "build" alternatives relative to the RTP Blend network, which is assumed to be in place as a baseline condition. The RTP Blend will accommodate substantial amounts of increased transbay travel through the Year 2010.

Within each evaluation criterion, bay crossing "build" alternatives have been evaluated relative to each other -- it was considered beyond the scope of this effort to define the absolute ranking of bay crossings alternatives compared to other regional transportation projects contained in the RTP Blend.

Summaries at the bottom of the evaluation tables list the number of "high", "moderate", and "low" evaluations for each alternative. The overall evaluation was based on the count of evaluations in each rank (i.e., no formal weighing system was developed).

At the end of the section, an overall summary is provided which condenses all of the information into a single page.

It should be noted that these simplified evaluation tables are not intended to supplant the more detailed information which is presented in the various reports which precede this evaluation study, and these reports should be referred to for additional details regarding the alternatives.

8.2 TRAVEL SYSTEM PERFORMANCE

Introduction

The ability of bay crossing alternatives to provide travel benefits is an important evaluation criteria, since it directly relates to the ability of each alternative to attain the intended benefits of improved transbay mobility and capacity.

As noted in the travel report, the alternatives have been evaluated in the Year 2010 against the Regional Transportation Plan, Alternative 4, Highway/Transit Blend (RTP Blend) scenario, which represents a mixture of transit and auto improvements. (Refer to Section 4, Travel Report, for a description of key relevant improvements included in the RTP Blend.)

Criteria Used to Evaluate Alternatives

Travel statistics were used to develop the "high", "moderate", and "low" rankings for quantitatively evaluated criteria. The following approach was used to determine the qualitative rankings.

<u>Goods Movement Potential</u>

Ranged from "low" for transit operators such as BART which have limited potential, to "high" for facilities such as a bridge or rail tunnel which could handle large trucks, containerized freight, or bulk freight vehicles.

Potential to Enhance Airport Access

Evaluated from the ability to improve access to/between San Francisco International Airport and Oakland International Airport, which represent the two key commercial aviation facilities in the heart of the study area. In general, the ranking is based upon the connectivity and proximity of the proposed facility to the respective airports.

Enhances Systemwide Travel Options

This criterion reflects a broad range of additional transportation opportunity as well as the degree to which an alternative closes a "missing link" in the regional transportation network.

Serves Economic Growth

The evaluation in this area was based upon the travel attractiveness of the alternative, in conjunction with the ability to address a "new market" for travel by providing significant new capacity or reduced travel time benefits to a distinct market.

Transportation Control Measure Performance

This criteria measures the ability of the alternative to attain the objectives of the Transportation Control Measures (TCMs), which are reduced highway vehicle miles and trips, increased transit usage, and which are intended to improve air quality and reduce highway congestion. The level of detail of the travel analysis was not sufficient to provide a comprehensive TCM evaluation. However, various quantitative travel criteria such as increased transit ridership, reduced auto vehicle miles, and travel time are indicators of TCM performance and have been identified as such in the evaluation table.

Ease of Implementation

The evaluation is based upon two key factors:

1. The relative construction complexity of each "build" alternative.

2. Consideration for institutional or factors which may need to be overcome.

This criterion does not reflect cost or financial feasibility, which is separately identified.

It must be emphasized that all alternatives (including construction of additional highway lanes included in the RTP Blend), with the exception of the scaled-back ferry alternative, represent major engineering construction efforts.

Evaluation Results

Figure 8-1 indicates the summary evaluation of travel benefits. The tabulation indicates ratings for each of the final five bay crossing alternatives in each travel characteristic assessed by the study. Within each evaluation criteria, alternatives were ranked on a relative basis from low to high. Table 8-1 provides the travel statistics used to rank the quantitative measures. The specifics for each alternative are addressed in the text which follows. (For comparison purposes, the RTP Blend results are also shown in Table 8-1.)

EVALUATION CRITERIA	ALT. 1 (Ferry)	ALT. 4/4A (Bridge + BART	ALT. 6 (Airport BART Tube)	ALT. 8 (Dual BART Tube)	ALT. 11 (Rail Tunnel)	
Daily Person Trips Carried	□	■	⬓	□	□	QUANTITATIVE MEASURES
Transit Ridership on Facility * (Increase over Blend)	⬓	■	■	□	⬓	QUANTITATIVE MEASURES
Net New Transit Ridership * (Compared to Blend)	□	□	■	□	□	QUANTITATIVE MEASURES
Reduction in Auto VMT * (Compared to Blend)	□	■	⬓	□	⬓	QUANTITATIVE MEASURES
Auto Travel Time Savings * (Vehicle Hours/Day)	□	■	⬓	□	⬓	QUANTITATIVE MEASURES
Goods Movement Potential	⬓	■	□	□	■	QUALITATIVE MEASURES
Potential to Enhance Airport Access	⬓	■	■	□	□	QUALITATIVE MEASURES
Enhances Systemwide Travel Options	⬓	■	■	□	⬓	QUALITATIVE MEASURES
Serves Economic Growth	□	■	⬓	□	■	QUALITATIVE MEASURES
Ease of Implementation	■	□	□	□	□	QUALITATIVE MEASURES
Summary of Ratings	□□□□□ ⬓⬓⬓⬓ ■	□□ ■■■■■■■■	□□ ⬓⬓⬓⬓ ■■■■	□□□□□□□□□□	□□□□ ⬓⬓⬓⬓ ■■	
Overall Rating	□	■	⬓	□	⬓	

* Indicates TCM Performance

LEGEND

- □ Low Relative Benefit
- ⬓ Moderate Relative Benefit
- ■ High Relative Benefit

Figure 8-1

TRAVEL PERFORMANCE EVALUATION

TABLE 8-1
TRAVEL PERFORMANCE STATISTICS

Evaluation Statistic	RTP Blend (Baseline)	Alt. 1 (Ferry)	Alt. 4 (Bridge + BART)	Alt. 6 (Airport BART Tube)	Alt. 8 (Dual BART Tube)	Alt. 11 (Rail Tunnel)
Person Trips Carried (Daily)	715,000	5,000	66,000	16,100	2,700	6,300
Transit Ridership on Facility (Daily)	183,554	5,000	12,000	16,100	2,700[1]	6,300
Net New Transit Ridership (Daily)[1]	n/a	600	1,600	10,000	2,700	1,300
Auto Vehicle Miles of Travel (Daily)/ Reduction[1]	111,142,784 n/a	-.02 %	-1.80 %	-0.11 %	-0.03 %	-0.13 %
Auto Travel Time Savings (Vehicle Hours/Day)[1]	n/a	200	20,000	1,200	400	1,500

[1] Compared to RTP Blend

Alternative 1: Enhanced Ferry Service

Quantitative Criteria

This alternative performed poorly relative to other bay crossing alternatives. The primary reason for this assessment was that the ferry system patronage estimate was low. Although a moderate level of patronage was forecast, the "net new ridership" was very low, indicating that most riders would be diverted from other transit services included in the baseline RTP Blend rather than from auto travel. The ferry services only showed limited ability to reduce auto travel, either in miles or travel time.

Qualitative Criteria

The goods movement potential and airport access for most routes would be limited. However, provision of specialized freight ferry service or an airport-to-airport ferry would be possible, resulting in a "moderate" evaluation. (Additional study will be necessary to quantify the potential travel benefit of such services.)

Ability to serve economic growth was evaluated as "low" since it would be limited to developments in the immediate vicinity of the terminal locations.

The ferry service can provide a direct transit connection between various points not otherwise provided by other transit services: There may be no transit connection between the points served, transfers may be necessary, or one or both ferry terminals may be within walking distance of the beginning or ending of the trip. Even when ferry service duplicates existing transit service, a ferry service may provide a different quality of transit experience which would prove attractive to riders. (For example, ferry riders may be able to find a seat on a ferry boat which they could not obtain on BART or a transit bus, and the ride may be more relaxed.) The ferry service option may therefore attract higher patronage than estimated in this study, in which the travel time was a key factor determining the estimated patronage. For these reasons, ferries were rated "moderate" in terms of enhanced systemwide travel.

Enhanced ferry services would be expected to be more easily implementable than any of the other alternatives. This is principally due to the fact that ferry services consist of a set of routes

which can be developed in an incremental fashion, if necessary. Even within a given point-to-point routing, staged investment in boats and terminal facilities may be accomplished. For these reasons, some level of improved ferry service could be attained at far lower cost than anticipated in the comprehensive route system tested in Alternative 1. (This issue is pursued further in the cost evaluation, when a refined ferry alternative is described.) For these reasons, the ferry alternative was ranked "high" in ease of implementation.

Overall Evaluation

The overall travel system performance evaluation of the enhanced ferry alternative was "low". However, enhanced ferry services on selected routes could be considered as part of a package aimed at improvement of transbay travel, especially in the near term.

Alternative 4: New Highway Bridge with BART

Quantitative Criteria

This alternative clearly rated the highest in travel performance of any of the alternatives studied. It would carry the greatest number of person trips (auto mode plus transit mode) and attracted a high number of transit riders.

Although the alternative would provide a new highway bridge, auto vehicle miles traveled would be reduced. This is due to the fact that the large "gap" between the Bay Bridge and San Mateo Bridge requires substantial amounts of additional driving distance and time for travel between northern San Mateo County near I-380 and points along the I-238/I-580 corridor which lie near the alignment of the new bridge. With the new bridge, regional auto miles of travel would be reduced by 1.8 percent. Trip lengths would decline due to increased "connectivity" of the highway network. This is equivalent to shortening the trip length of the some 550,000 daily transbay vehicle crossings by about 3.6 miles. To put this in perspective, the MTC Transportation Control Plan estimates approximately the same level of auto travel reduction through the use of subsidized transit and ridesharing in its "contingency" TCM plan.

The new bridge would reduce daily travel on the Bay Bridge and would reduce the duration of peak direction congestion (which is expected to more than double by the Year 2010 with the RTP Blend) by one hour. This alternative therefore resulted in the greatest auto travel time savings.

Qualitative Criteria

The new bridge would provide a new transbay truck route, which could reduce truck volumes on the Bay Bridge and which would reduce the length of truck trips between northern San Mateo County and the I-238/I-580 corridor in the East Bay, in a similar fashion to the auto travel reduction.

Travel time between the San Francisco and Oakland Airports would be substantially reduced, resulting in improved access between these two facilities as well as destinations on the opposite side of the Bay from each facility.

Systemwide travel options would be enhanced by provision of a new multimodal facility capable of filling the "gap" in the roadway network (affecting autos as well as trucks) as well as providing a new BART connection to the Peninsula and San Francisco which could allow for new BART operating plans for serving those areas from the East Bay.

The new bridge could serve economic growth targeted for the San Francisco International Airport vicinity, including San Bruno, South San Francisco, and Brisbane, as well as development in Alameda County along the I-238/I-580 corridor.

The new bridge was evaluated to be "low" in terms of ease of implementation, similar to most of the alternatives: While minimal amounts of dredging would be involved, the East Bay approach would require construction of a new highway through an established residential neighborhood. Considerable amount of consensus would need to occur to allow construction of a new bridge crossing, given the history of the previous "Southern Crossing" proposal.

It should be noted that the highway demand identified by the Year 2010 would not warrant construction of an eight-lane bridge as the alternative was originally specified. (For this reason, a smaller, staged version is discussed in the cost evaluation.)

Summary

In summary, it was concluded that this alternative would rank "high" in travel system performance, relative to other "build" alternatives studied.

Alternative 6: Airport-to-Airport BART Tube

Quantitative Criteria

This alternative ranked second in terms of the number of total person trips carried and first in terms of the number of transit trips carried. It would result in a significant net new transit ridership and would provide a measurable reduction in auto vehicle miles traveled compared to the baseline RTP Blend. A moderate amount of reduction in auto travel time would occur.

Qualitative Criteria

The goods movement potential would be "low". However, significant improvement to San Francisco and Oakland Airport's access for passengers and employees would be provided. The alternative would rank "high" in terms of enhanced system-wide travel options, due to the fact that BART trains could be run between the Peninsula and central-southern Alameda County via a new route, allowing for a new set of BART operating plan options. Service to economic growth was ranked "moderate" (it would have been higher had greater patronage levels been reported).

Ease of implementation was ranked "low" as were most new bridge and tunnel alternatives. Although a new BART tube would not seem to have high landside impacts along the approach to the Bay, the 1.8-million cubic yards of dredging which would be necessary represents a major spoils problem for which there is no current institutionally-agreed upon solution. In addition, aerial structures would pass through existing residential neighborhoods in the East Bay to make the connection with the new Dublin-Pleasanton line.

Summary

In summary, it was concluded that this alternative would rank "moderate" in travel system performance.

Alternative 8: Dual BART Tube

Quantitative Criteria

While this alternative was located in the prime travel corridor served by the heavily congested Bay Bridge, the total amount of BART patronage indicated with a second BART tube at this location was not significantly higher than the projected patronage in the existing tube with the baseline RTP Blend network. Therefore, while significant numbers of passengers could be carried by this facility, nearly all would be diverted from the existing BART tube. (With the RTP Baseline numbers indicating the BART tube would not be significantly over capacity in 2010, there would not be adequate justification for construction of a second tube at this time.) Consistent with this evaluation, this alternative would result in small decreases in auto travel.

Qualitative Criteria

Low potential for goods movement or improved airport access would occur. A "low" improvement in systemwide travel options would occur, with new service limited to one new BART station at Mission/Beale and one at Union Square (no new East Bay stations). Ability to serve economic growth would be similarly limited since no significant new transit coverage would be provided. Implementation would also be "low", involving complex subway tunneling projects through downtown San Francisco, and modification to the Oakland wye and development of a fourth track through downtown Oakland in addition to a new transbay tube in addition to disposal of dredge spoils.

Summary

In summary, this alternative ranked "low" in travel system performance.

Alternative 11: Rail Tunnel

Quantitative Criteria

This alternative ranked "low" in terms of total daily person trips carried. With ridership comparable to the enhanced ferry service alternative, the transit patronage was ranked "moderate", however, the net new transit ridership was "low" compared to the RTP Blend, indicating that transit trips were diverted from other transit facilities in the RTP Blend. It is estimated that this alternative would result in a "moderate" reduction in auto vehicle miles traveled and auto travel time savings relative to the RTP Blend.

Qualitative Criteria

This alternative would provide trackage capable of accommodating freight service between the East Bay and industrial areas along the bayfront in northern San Mateo County and San Francisco. Such a connection could allow development of an intermodal ship-to-rail terminal at the Port of San Francisco and could reduce container truck traffic on the Bay Bridge. Therefore, the goods movement potential would be "high". Airport access would be "low". Persons would be able to board a train anywhere between Auburn-Oakland-San Jose bound for San Francisco and the Peninsula, thereby resulting in a "moderate" increase in systemwide travel options. This improved transit coverage, in conjunction with the previously-mentioned goods movement potential would result in a "high" ability to serve economic growth. Similar to the dual BART transbay tube, this facility would be rated "low" in terms of ease of implementation due to rail connection issues and the dredge spoils problem.

Summary

In summary, this alternative was ranked "moderate" in transbay travel performance.

Overall Rating

Based upon the number of "high", "moderate", and "low" scores, Alternative 4/4A (Bridge + BART) was ranked "high", Alternatives 6 (Airport-to-Airport BART) and 11 (Rail Tunnel) were ranked "moderate", and Alternatives 1 (Ferry) and 8 (Dual BART Tube) were ranked "low".

8.3 ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACT

Introduction

The evaluation of environmental and socio-economic impacts includes all of the criteria addressed in the Environmental and Socio-Economic assessment with the exception of consistency with regional and local plans, which was an area in which "high", "moderate", and "low" evaluation was not feasible.[1] It should be noted that impacts associated with the Base Case condition (RTP "Blend") were not evaluated as part of this study. Such impacts will be evaluated in a separate EIR being prepared for the Regional Transportation Plan by MTC.

Criteria Used to Evaluate Alternatives

The criteria used to determine the relative level of impact for environmental considerations were based on a combination of quantitative and qualitative factors which are summarized below.

Ecology

The level of impact on ecology was based on an alternative's potential to impact wetlands, endangered species, marine resources due to dredging, or other known sensitive resources.

Geology

Geology impact ratings were based on susceptibility to groundshaking and potential risk of failure or closure during a seismic event. The potential for seismic impacts was determined to be greater where elevated, land-based structures were involved, whereas a tube beneath the Bay would have a lower risk of damage due to its flexibility, buoyancy, and location in a higher density medium (water).

---

[1] The Environmental and Socio-Economic Assessment included a discussion of Consistency with General Plans and Zoning. This topic is not included in the Evaluation matrix since the determination of consistency with local and regional plans and policies is the purview of each individual agency/jurisdiction and it is not feasible to give a ranking of "high impact", "moderate impact", or "low impact".

Dredging and Water Quality

Impacts on dredging and water quality were based on the amount of dredge material involved, from very low with Alternative 1 (0.025 million cubic yards), to high with Alternative 6 (11.8 million cubic yards).

Noise and Vibration

Noise and vibration impact ratings were based on increased noise levels in the community primarily due to the proximity of each of the alignments to residences and other sensitive receptors.

Air Quality

Air quality impacts used travel forecasting data prepared by MTC to estimate the potential Hydrocarbon emissions for each alternative in 2010, relative to the Regional Transportation Plan "Blend" Alternative.

Land Use

For socio-economic considerations, a high impact rating on land use was based on the potential for neighborhood disruption and displacement of housing and businesses, while lower rankings indicate little or no displacement.

Visual

The visual quality assessment focused on the long-term visual effects of project implementation, including blockage of views to and from the Bay.

Construction Impacts

Construction impacts assessed impacts that were short-term and temporary in nature, including both construction and staging activities, and focused on such issues as geology, air quality (dust), visual impact, and noise.

Growth Inducement

The growth inducement rating is based on the potential of an alternative to generate new growth beyond that which is already planned to occur in the region. The relationship between transportation and land use is exceedingly complex. Since the Bay Crossing Alternatives are being proposed at a time and in a location where economic pressures for growth are very strong, it is unlikely that any of the Alternatives could induce growth on a regional scale over what is already expected to occur. *Projections 90* indicate that the conditions supporting growth, and hence the largest amounts of growth, will occur in Santa Clara, eastern Alameda, eastern Contra Costa,and Solano Counties. None of the Alternatives will provide significant new transportation capacities to or from these areas.

All of the Alternatives would, as a result of their location, tend to reinforce the existing urban patterns of development and location of metropolitan centers in the East and West Bay. By encouraging infill development, rather than growth in new areas, all of the Alternatives can be considered "growth-directing" and none are considered growth-inducing.

Energy Use

The criteria for evaluation energy use is the ability of a given alternative to reduce total Vehicle Miles Traveled (VMT). For example, a high rating in energy use was given to alternatives that did not significantly reduce automobile travel (Alternatives 1 and 8), while a low impact rating was projected for the alternative that would reduce regional trip lengths overall (Alternative 4).

Evaluation Results

The evaluation of the relative environmental and socio-economic effects associated with each of the alternatives is summarized in Figure 8-2 and discussed below.

EVALUATION CRITERIA	ALT. 1 (Ferry)	ALT. 4/4A (Bridge + BART)	ALT. 6 (Airport BART Tube)	ALT. 8 (Dual BART Tube)	ALT 11 (Rail Tunnel)
Ecology	□	■	■	⬓	⬓
Geology (Seismicity)	□	■	■	⬓	⬓
Dredging & Water Quality	□	□	■	■	■
Noise & Vibration	□	■	■	⬓	⬓
Air Quality	□	□	□	□	□
Land Use	□	■	■	⬓	□
Visual	□	■	■	□	□
Construction Impacts	⬓	■	■	⬓	⬓
Energy Use	■	□	⬓	■	⬓
Growth Inducement	□	□	□	□	□
Summary of Ratings	□□□□□□□□ ⬓ ■	□□□□ ■■■■■■	□□ ⬓ ■■■■■■■	□□□ ⬓⬓⬓⬓⬓ ■■	□□□□ ⬓⬓⬓⬓⬓ ■
Overall Rating	□	■	■	⬓	⬓

LEGEND

□ Low Impact

⬓ Moderate Impact

■ High Impact

Figure 8-2

ENVIRONMENTAL AND SOCIO-ECONOMIC ASSESSMENT

Alternative 1: Enhanced Ferry Service

Of the five alternatives studied, Alternative 1 would result in the lowest overall level of relative environmental and socio-economic impacts. Operational impacts are rated low in nearly all categories, including ecology, geology, dredging and water quality, noise and vibration, air quality, land use, and visual.

Construction impacts resulting from the improvement and/or construction of combined land and water facilities required at the 17 identified ferry terminal locations were rated as moderate overall, although there is considerable discrepancy among the existing improvements at the 17 locations studied. Seven of the proposed terminal locations now have ferry service or had it during the post-earthquake months (San Francisco Ferry Terminal, Oakland, Alameda, Vallejo, Richmond, Berkeley, and Bay Farm Island), six of the identified terminal locations would be located in existing ports or marinas (Martinez, Rodeo, San Leandro, Oyster Point, Coyote Point, and Redwood City), while the remaining four would involve new terminal facilities (Benicia, Oakland Airport, San Francisco Airport, and Pier 24). Short-term, temporary impacts would be due to construction of docks, terminal facilities, parking facilities, access roads and, in some cases a long-span loading pier. Further, shipping and land-based movement of goods and services could be negatively impacted during construction. This alternative was rated high in terms of energy use since it did not attract sufficient users to reduce vehicle miles traveled.

The enhanced ferry system would, to a large extent, serve commuters already making trips on existing freeways or using BART and buses to cross the Bay. While the ferries could provide commuting alternatives and allow room for new travelers, the travel forecasting results indicate that they would increase transbay travel by only 5,000 person trips a day, out of over 5 million projected in 2010. While ferry ridership would be many times today's levels, the regional effect is small and the project is more likely to be categorized as congestion management than capacity expansion.

Summary

Alternative 1, with eight out of ten ratings indicated as "low" had an overall rating of "low" impact.

Alternative 4/4A: New Highway Bridge with BART

Construction of a bridge connecting the vicinity of San Leandro/San Lorenzo and South San Francisco has an overall rating of high as a result of significant land-based impacts. Impacts on land use are most severe in the East Bay, where either of the alternative freeway alignments would cut through established single-family residential neighborhoods. The alignment of Alternative 4 through San Leandro could displace all or a portion of residents located in the 840-unit Lakeside Village apartment complex located to the north of the new interchange of I-238 and I-880 as well as a portion of the retail businesses located in the triangle of land formed by Lewelling, Washington, and I-280. As the alignment proceeds west following Manor Boulevard, approximately 110-120 residential units would be displaced in addition to businesses located west of I-880. The freeway structure would create a physical barrier between established neighborhoods with the resultant noise, vibration, and visual, impacts.

Alternative 4A would reduce land use impacts somewhat, as compared to Alternative 4. Business could be impacted or displaced at the Interchange of I-880 and I-238, between Hesperian Boulevard and Washington Avenue. The alignment would be elevated over San Lorenzo Creek which forms the boundary between residential neighborhoods in San Leandro and San Lorenzo. Although homes would not be displaced, the freeway would generate significant noise, vibration, dust and particulates, and visual impacts due to the height and bulk of the elevated structure both during construction and project operation.

Potential impacts to known wetlands resources in both the East Bay and West Bay segments during construction resulted in a high rating in the ecology category. In the West Bay, a 1-2 acre diked seasonal wetland would be affected by the proposed station location near South Airport Boulevard. The interchange with I-380 could affect 2-5 acres of tidal marsh and a small area of diked vegetated wetlands. The endangered San Francisco Garter Snake has been found in seasonal wetlands near the airport. In the East Bay, the alignment for Alternative 4 would be located at the northern boundary of a 471-acre wetland in which an endangered species, the Salt Marsh Harvest Mouse, have been found. Alternative 4A would cross almost a mile of tidal

mudflats and could affect areas of San Lorenzo Creek which is partly tidal marsh and partly tidal creek. Since the bridge structures for both 4 and 4A are elevated, neither would result in a total filling of wetland areas; however, short-term construction impacts could become a major concern.

Based on travel forecasting data, air quality impacts are anticipated to be low, as compared to the RTP "Blend" Alternative for 2010. The elevated bridge structure would traverse geologic units with very high to extremely high susceptibility to groundshaking in the event of an earthquake. Impacts on dredging and water quality were determined to be low as the elevated bridge structure would be constructed on sunken caissons requiring the removal of approximately 0.024 million cubic yards of dredge material. Energy use associated with the bridge/BART alternative was rated as low since a new bridge would reduce VMT, reflecting the fact that the bridge would reduce trip length overall.

Alternative 4 would provide a major new high capacity link in the regional transportation network; however, it is not likely to induce growth beyond the 15 percent increase in regional population projected to occur between 1990 and 2005. While this alternative would increase mobility between East Bay and West Bay points, it would not improve the transportation connection between labor deficit areas and potential new residential development areas. Travel forecasting results indicate that 64 percent of the origins of users of the new bridge would be in western Alameda county, while 11 percent would be in eastern Alameda County. The travel distance is so great that it is unlikely to induce an extra measure of growth over what is currently projected.

<u>Summary</u>

With more than half of the categories falling in the "high" impact range, Alternative 4/4A was given an overall rating of "high" impact.

Alternative 6: Airport-to-Airport BART Tube

Alternative 6 had the highest impact rating overall, in large part due to the unprecedented length of the tube under the Bay, in addition to the land-based impacts. Dredging of as much as 11.8 million cubic yards, which would be equivalent to the annual average for all dredging activity in the Bay in 1986 and 1987, resulted in a high rating in the category of dredging and associated water quality impacts. Dredging activities associated with an 11-mile long dredged trench would

also result in ecology impacts beneath the Bay and land-based impacts as the tube emerges near a diked, seasonal wetland south of Airport Boulevard in the East Bay. Elevated structures would be constructed on geologic units with very high to extremely high susceptibility to groundshaking from earthquakes.

In the East Bay, west of I-880 to the SPRR line, land use impacts would be significant due to the location of the alignment through an established residential neighborhood in San Leandro. The alignment would place an elevated BART structure over local neighborhood streets, displacing approximately 50 to 70 homes, and impacting or displacing a junior high school, elementary school, and a church school. The structure would create a visual barrier dividing the neighborhood and generate noise and vibration impacts.

From Doolittle Drive west to the Bay, the alignment would pass through Oakland International Airport lands which are constrained by a number of important factors, including sensitive hydrophytic plant communities and water bodies, and potential conflicts with existing and future airport master planning activities, particularly the location of short-term and long-term airport parking facilities.

Using travel forecasting data, air quality impacts are projected to be low when compared with the RTP Blend Alternative for 2010. Based on the reduction in VMT, Alternative 6 is projected to have a moderate impact on energy use.

A BART connection between the two major airports would be mostly responsive to trends toward increasing mobility of the people of the Bay Area in general, rather than inducing growth. Both airports are developing expansion plans to meet projected increases in air traffic. Alternative 6 would fit into a specialized niche, accommodating improved access to the two regional airports; however, it would pay almost no direct role in directing the intensity, location, or rate of regional economic and population growth.

<u>Summary</u>

Primarily due to the additional dredging and water quality impacts associated with tube construction, Alternative 6 had the greatest number of "high" impacts and was therefore given an overall rating of "high" impact.

Alternative 8: Dual BART Tube

The overall rating for Alternative 8 is "moderate". A high impact in the category of dredging and water quality is due to the need for approximately 3.9 million cubic yards of dredging activity. Dredging activities could also result in moderate ecological impacts along the length of the 3.5 mile dredged trench.

Land-based impacts are expected to be moderate to low, since the alignment is underground and the proposed construction methods between stations entail tunneling, rather than the more damaging cut-and-cover method. Land use, noise and vibration, and construction impacts are expected to be moderate due to cut-and-cover station construction techniques. Visual and air quality impacts are expected to be low with this underground alignment. This alternative would be predominately sub-surface, with the 1.9 miles of surface-mounted structures subject to moderately to extremely high susceptibility to groundshaking. This alternative would have a high impact on energy use, due to the limited number of users and inability to significantly reduce VMT. Based on travel forecast data, air quality impacts are projected to be low as compared to the RTP Blend Alternative in 2010.

Alternative 8 provides redundancy and an increase in the capacity of the existing BART transbay link, and it would reinforce existing jobs/housing and commute patterns rather than inducing additional regional growth.

<u>Summary</u>

Alternative 8, with a majority of the ratings falling in the "moderate" to "low" categories, was ranked overall as having "moderate" impact.

Alternative 11: Rail Tunnel

The rating of "moderate" for the Inter-City Railroad Tunnel is based on an even split of low and moderate level impacts, with a high rating only in the area of dredging and water quality, due to the necessity to dredge 6.1 million cubic yards. Dredging activity could also result in moderate ecology impacts in the Bay.

Noise and vibration impacts are rated as "moderate" in the East Bay where the alignment passes at-grade through existing commercial and industrial buildings. Based on travel forecast data, air quality impacts are projected to be low when compared to the RTP Blend Alternative.

Land use and visual impacts are rated low inasmuch as the alignment traverses industrial areas in both the East and West Bay and rail and passenger train facilities would be compatible with existing and proposed uses. Approximately 2.5 miles of the 7.5 mile alignment would be subject to high to extremely high groundshaking in the event of an earthquake. Cut-and-cover construction techniques result in a moderate rating due to potential impact on railroad operations. VMT were reduced with Alternative 11, resulting in a moderate energy use impact.

The railroad alternative would not induce growth over what is projected to occur regionally; however, it would facilitate movement of goods and passengers across the Bay and reinforce existing rail and seaport facilities at the terminus in the Port of Oakland.

Summary

Alternative 11, with a majority of the ratings falling in the "moderate" to "low" categories, was ranked overall as having "moderate" impact.

Overall Evaluation

The overall rating was based on the sum of the individual criteria as follows: Alternative 1 (Ferry), with eight out of ten ratings indicated as "low" had an overall rating of "low"; Alternatives 8 (Dual BART Tube) and 11 (Rail Tunnel) with a majority of the ratings falling in the "moderate" to "low" category, were ranked overall has having "moderate" impact. Alternatives 4 (Bridge with BART) and 6 (Airport-to-Airport BART), with more than half of the categories falling in the "high" impact range, were given an overall rating of "high" impact.

8.4 COST EVALUATION

Introduction

The cost evaluation provides a comparative evaluation of the capital investment as well as ongoing Operations and Maintenance (O&M) costs associated with each of the bay crossing alternatives.

For the purpose of providing an aggregate cost figure reflecting both capital as well as O&M costs, the capital costs were annualized in accordance with a formula approved by the Urban Mass Transportation Authority (UMTA). Two key factors were used in the annualization formula:

- Assumed life cycle of 30 years

- Assumed discount rate of 10 percent (reflecting both the cost of funds as well as an underlying implied rate of inflation)

Revised Alternatives

After the travel performance analysis was prepared and reviewed, it became apparent that Alternative 1 (Enhanced Ferry System) and Alternative 4/4A (New Highway Bridge plus BART) should be refined to provide a more cost-effective solution.

The revised alternatives have been carried forward as "cost alternatives" only, and it was considered beyond the scope of the effort to perform additional travel modeling studies or updated environmental assessments for the revised alternatives. (However, it would be expected that the revised alternatives would have travel performance and impacts similar to the originally-defined alternatives.)

Revised Alternative 1

A "revised" cost estimate was prepared for the ferry system which would retain the top five routes in terms of patronage, which were as follows:

- San Francisco to Vallejo
- San Francisco to Rodeo
- San Francisco to Richmond
- San Francisco to Alameda
- San Francisco to Bay Farm Island

This scaled-down system would require significantly less investment in boats and terminal facilities, and would require only one wholly new terminal (Rodeo).[1]

---

[1] It is possible that quantification of the favorable travel benefits due to goods movements or air passenger transfers may allow the addition of the San Francisco Airport to Oakland Airport ferry line. Therefore, while this line is not included in the revised Alternative 1 system, it should be further studied.

While it is recognized that a reduction in the system could result in a lower patronage estimate, only a limited amount of patronage was obtained from the routes which have been dropped. Furthermore, it is likely that in the interim years prior to implementation of rail or High Occupancy Vehicle (HOV) lane projects in the I-80 corridor, patronage will be significantly higher to points north of the Bay Bridge. Therefore, the refined ferry system is treated as a cost refinement only, and no further adjustment of the ridership estimate was accomplished.

Revised Alternative 4/4A

As noted in the Travel Report, the new bridge did not attract enough auto travel to warrant construction of an eight-lane facility in the Year 2010. Also, BART ridership estimated for the new bridge line was in scale with current A.C. Transit ridership on the Bay Bridge and the existing BART tube would not be significantly over capacity. The following revisions to Alternative 4/4A were made:

- Reduce highway lanes from eight to four
- Defer implementation of BART until a later point in time

With these changes, the revised Alternative 4/4A would be defined as follows:

Phase I: four-lane highway bridge with adequate foundation to be "BART capable"

Phase II: four-lane highway bridge with BART

(Given the uncertainty associated with travel forecasting beyond the Year 2010, it is also possible that a Phase II widening of the new bridge could provide interim HOV/bus transit lanes until such time as a new BART line would be warranted.)

Revised cost estimates for Alternative 4/4A separate out the initial "BART capable" four-lane highway bridge cost from an "add BART" subsequent cost. In either case, the cost of a bicycle/pedestrian facility was not included in the estimates. In the evaluation which follows, the Phase I results are based upon the cost and travel performance of the highway bridge alone, while Phase II results are based upon the total cost and performance (highway plus BART).

Figure 8-3 shows the evaluation of the original and refined alternatives. The cost per trip information is based upon the total yearly cost (capital plus operations and maintenance) divided by annual trips.

The companion Table 8-2 provides the specific cost factors which were used to perform the evaluation.

Evaluation Results

The following comments pertain to the evaluation of each alternative.

Alternative 1: Enhanced Ferry Service

Original Alternative

While the originally-specified Alternative 1 would have a relatively low capital cost, it would also have the highest O&M cost of any of the alternatives studied. Thus, the resulting total annual cost would have been "moderate". In conjunction with the low ridership projection, the original ferry alternative would have resulted in a "moderate" cost per trip.

Revised Alternative

The revised, five-route ferry service alternative would have resulted in significant reductions in both capital and O&M cost, such that the overall annual cost as well as cost per trip would be considered in the "low" range relative to other bay crossing alternatives.

Summary

In summary, the original ferry alternative would be a moderate cost option, while the revised, downscaled system would be a low cost option.

EVALUATION CRITERIA	ALT. 1 (Ferry)	ALT. 1 Revised (Ferry)	ALT. 4/4A (Bridge + BART)	ALT. 4/4A Revised (Phase I, Bridge)	ALT. 4/4A Revised (Phase II, Bridge + BART)	ALT. 6 (Airport BART Tube)	ALT. 8 (Dual BART Tube)	ALT. 11 (Rail Tunnel)
Overall Annual Cost	⬓	□	■	⬓	⬓	■	■	⬓
Cost per Person Trip	⬓	□	□	□	□	⬓	■	⬓
Cost per Vehicle-Mile Reduced	■	⬓	□	□	□	⬓	■	⬓
Summary	⬓ ⬓ ■	⬓ □ □	□ □ ■	□ □ ⬓	□ □ ⬓	⬓ ⬓ ■	■ ■ ■	⬓ ⬓ ⬓
Overall Evaluation	⬓	□	⬓	□	□	⬓	■	⬓

LEGEND

□ Low Cost
⬓ Moderate Cost
■ High Cost

Figure 8-3
COST EVALUATION

TABLE 8-2
COST EVALUATION FACTORS

Evaluation Statistic	Alt. 1 (Ferry)	Alt. 1, Rev. (Ferry)	Alt. 4 (Bridge + BART)	Alt. 4, Rev. (Phase I Bridge)	Alt. 4, Rev. (Phase II Bridge + BART	Alt. 6 (Airport BART Tube)	Alt. 8 (Dual BART Tube)	Alt. 11 (Rail Tunnel)
Annualized Capital Cost ($-million)	78	26	327	147	222	391	253	165
Annual O&M Cost ($-million)	103	50	30	3	30	27	27	20
Total Annual Cost ($-million)	181	76	357	150	252	418	280	185
Total Annual Cost per Person-Trip ($)	122	51	16	8	11	88	345	100
Total Annual Cost per Reduced Mile of Auto Travel ($)	31.50	13.00	0.50	0.20	0.35	10.00	20.00	3.50

This does not include costs associated with automobile travel, including private auto ownership and private auto operating costs and environmental mitigation costs.

Alternative 4: New Highway Bridge with BART

Original Alternative

The originally specified Alternative 4/4A would have a "high" capital cost and "moderate" O&M cost, resulting in a "moderate" annual cost. The resulting cost per trip would be in the "low" range relative to other bay crossing alternatives studied.

Revised Alternative

Phase I:

The first phase of the revised alternative (new four-lane bridge) would result in a reduced capital cost of approximately one-half of the original alternative, placing this option in the "moderate" category of capital cost. The revised Phase I project would have the lowest yearly O&M cost of any of the alternates studied. The total yearly cost would be in the "moderate" range. However, given the high number of trips served, the resulting cost per trip would be the lowest of the alternatives studied. The overall cost evaluation would be in the "low" category.

Phase II:

The second phase of the revised alternative (four-lane bridge with BART) would remain in the "moderate" category in terms of capital cost. The O&M cost and total annual cost would also be in the "moderate" category. The high number of trips attracted would result in a "low" cost per trip compared to other bay crossing alternatives. The overall cost evaluation would be in the "moderate" category.

Alternative 6: Airport-to-Airport BART Tube

This alternative would entail the highest capital cost of any of the alternatives, primarily due to the higher cost of a tunnel than a bridge as well as the significantly greater length of the alternative. O&M costs would be in the "moderate" category, but the combined yearly cost would remain "high". Attraction of significant ridership compared to other alternatives would result in a "moderate" cost per trip. The overall cost evaluation would be "high".

Alternative 8: Dual BART Tube

This alternative would be less costly in terms of capital cost than Alternative 6, resulting in a "moderate" score. O&M costs would be approximately the same as for Alternative 6, resulting in a total yearly cost which would be lower yet in the "moderate" category. The limited amount of additional ridership, however, results in very high costs per trip between Oakland and San Francisco, compared to the RTP Blend level. In summary, this alternative would be a "high" cost option.

Alternative 11: Rail Tunnel

This option would require a "moderate" capital investment, at about the same level as Phase I of the revised Alternative 4. O&M cost would also be "moderate", resulting in a "moderate" total annual cost. However, somewhat limited ridership would result in a cost per trip which would be higher than either of the mid-bay BART alternatives. It should be noted that a rail tunnel would also have significant freight-hauling potential. The summary evaluation for this alternative is "moderate".

Overall Evaluation

Based upon the individual scores in each category, the alternatives with relatively "low" cost would be Alternative 1, revised (Ferry) and Alternative 4/4A, revised, Phases I and II (four-lane Bridge with BART). Relatively "moderate" cost options would include Alternatives 4/4A (eight-lane Bridge with BART), 6 (Airport-to-Airport BART), and 11 (Rail Tunnel). Alternative 8 (Dual BART Tube) was found to be a "high" cost option.

8.5 FINANCIAL EVALUATION

Introduction

The financial evaluation characterizes the relative fundability of each of the bay crossings alternatives, irrespective of the travel demand or of the opportunity cost associated with use of funds. This evaluation is based upon the ability of toll increases on the southern bridge group

(Dumbarton Bridge, San Mateo Bridge, Bay Bridge, and New Bridge, if applicable) to provide a significant contribution towards the estimated capital cost of each bay crossing alternative. (It must be recognized that federal interstate monies may be available which would pay for a significant portion of a new highway crossing, particularly if the new crossing were designated as an I-380 facility. Similarly, Federal Urban Mass Transportation Act (UMTA) funds may be available to support the rail options. Such additional sources of funds could further enhance the absolute financial viability of bay crossing improvements.)

The test applied was the degree to which a "market level" toll in the Years 2000 - 2030 fund the capital investment required for the bay crossing alternative. A $4 toll increase (in the Year 2000) was considered to reflect "market level" pricing. Such an increase was the highest level of toll increase recommended for analysis by the Policy and Advisory Committees providing input to this study. However, recent polls have indicated a willingness for the public to accept significantly higher tolls on bridges.[1] Such an increase, if discounted to 1990 dollars, would be equivalent to charging $3.45 for a transbay auto trip today. It should be noted that tolls in this range are not uncommon; current trans-Hudson tolls in the New York metropolitan area are $3.00 and the Port Authority is considering the need to raise these tolls to fund maintenance and regional capital improvements.

A $4 increase in the Year 2000 would generate approximately $1.5-billion (1990 dollars) in bonding capacity.[2] Alternatives in which the mid-point estimated capital expense could be 100 percent funded by such a toll increase were categorized as "high" in terms of fundability, alternatives which would be 50 percent fundable through the toll increase were categorized as "moderate", and alternatives which would be less than 50 percent fundable through the toll increase were categorized as "low" in terms of their fundability.

Except for Alternative 1 (Ferry) the O&M costs do not appear to be a significant factor in determining the ultimate financial feasibility, and were not considered for the following reasons: Firstly, for the highway bridge, very low maintenance costs were estimated. Secondly, for rail

---

[1] Public Opinion Poll by Bay Area Council, January 8, 1991, as reported in San Francisco Examiner.

[2] The bonding capacity takes into account reductions in total toll intake which would be projected to occur due to reduced highway travel resulting from the toll increase.

transit alternatives such as BART (Alternative 4, 6, and 8) and CalTrain (Alternative 11), operating costs for these segments represent a relatively small portion of the overall system operating cost. (While the ferry system O&M costs would be considerable in relationship to potential farebox, toll funding would allow for the possibility of using toll revenues to partially subsidize operations.)

Evaluation Results

The results of the evaluation are shown in Figure 8-4. Table 8-3 provides the corollary toll funding to cost statistic used in the evaluation. "High" financial feasibility was found for the enhanced ferry services (as originally defined or as subsequently revised), Phase I of the revised Alternative 4/4A (Four-Lane Highway Bridge), and Alternative 11 (Rail Tunnel). "Moderate" financial feasibility was found for Phase II of the revised Alternative 4/4A (Four-Lane Highway Bridge plus BART) and Alternative 8 (Dual BART Tube). The original Alternative 4/4A (Eight-Lane Highway Bridge plus BART) and Alternative 6 (Airport-to-Airport BART) would have "low" financial feasibility.

It should be noted that the financial feasibility is a relative analysis of the build alternatives and that there could be significant "opportunity cost" to other proposed projects which would rely upon increased toll revenues or other sources of funds. (See Section 7.7 for projects which could potentially be affected.)

EVALUATION CRITERIA	ALT. 1 (Ferry)	ALT. 1 Revised (Ferry)	ALT. 4/4A (Bridge + BART)	ALT. 4/4A Revised (Phase I, Bridge)	ALT. 4/4A Revised (Phase II, Bridge + BART)	ALT. 6 (Airport BART Tube)	ALT. 8 (Dual BART Tube)	ALT. 11 (Rail Tunnel)
Toll Funding Relative to Capital Cost	■	■	□	■	⬓	□	⬓	■

LEGEND

□ Low Feasibility

⬓ Moderate Feasibility

■ High Feasibility

Figure 8-4
FINANCIAL EVALUATION

TABLE 8-3
FINANCIAL FUNDABILITY
Based upon Toll Revenues and Facility Capital Cost

Evaluation Statistic	Alt. 1 (Ferry)	Alt. 1, Rev. (Ferry)	Alt. 4 (Bridge + BART)	Alt. 4, Rev. (Phase I Bridge)	Alt. 4, Rev. (Phase II Bridge + BART	Alt. 6 (Airport BART Tube)	Alt. 8 (Dual BART Tube)	Alt. 11 (Rail Tunnel)
Percent of Capital Cost Covered by Toll Funding ($4 increase)	210%	620%	50%	110%	75%	40%	65%	100%

8.6 COST TO TRAVEL PERFORMANCE EVALUATION

Introduction

While the level of detail of the analysis is not sufficient to provide a rigorous cost-benefit assessment, the cost and ridership estimates can be used to group alternatives into one of four high/low groups. Two x/y plots have been prepared using travel performance and cost statistics. The vertical axis of the plots shows increasing levels of benefit, while the horizontal axis shows increasing levels of total cost (annualized capital plus O&M cost). The best alternatives are those which provide high benefit and low cost (plotted in the upper left quadrant); the poorest are those which provide low benefit and high cost (plotted in the lower right quadrant).

Evaluation Results

Two benefit categories were evaluated: "total trips carried" and "daily auto trips reduced". Figures 8-5 and 8-6 indicate the benefit to cost relationships. The figures are similar since the relative number of trips carried by each alternative is similar to the relative reduction in vehicle miles traveled.

The figures indicate that the revised Alternative 4/4A would fall in the high benefit/low cost quadrant, indicating it would provide the highest cost/benefit ratio. Alternative 1 (enhanced ferry services) and Alternative 11 (Rail Tunnel) would provide low cost/low benefit solutions, while the original Alternative 4/4A (Eight-Lane Bridge plus BART) would provide a high cost/high benefit solution. Alternatives 6 (Airport-to-Airport BART) and 8 (Dual BART Tube) would be high cost/low benefit solutions compared to other bay crossing alternatives.

Overall Evaluation

Alternatives 8 (Dual BART Tube) and 6 (Airport-to-Airport BART) were found to be "low" in benefit to cost since they are in the low benefit/high cost quadrant. Alternative 4, revised (four-lane Bridge with BART) was found to be "high" in benefit to cost since Phase I and Phase II are in the high benefit/low to moderate cost range. The other alternatives, evaluated as "moderate", include the high benefit/high cost Alternative 4/4A (Eight-Lane Bridge with BART) and low benefit/low cost Alternatives 1 (Ferry) and 11 (Rail Tunnel).

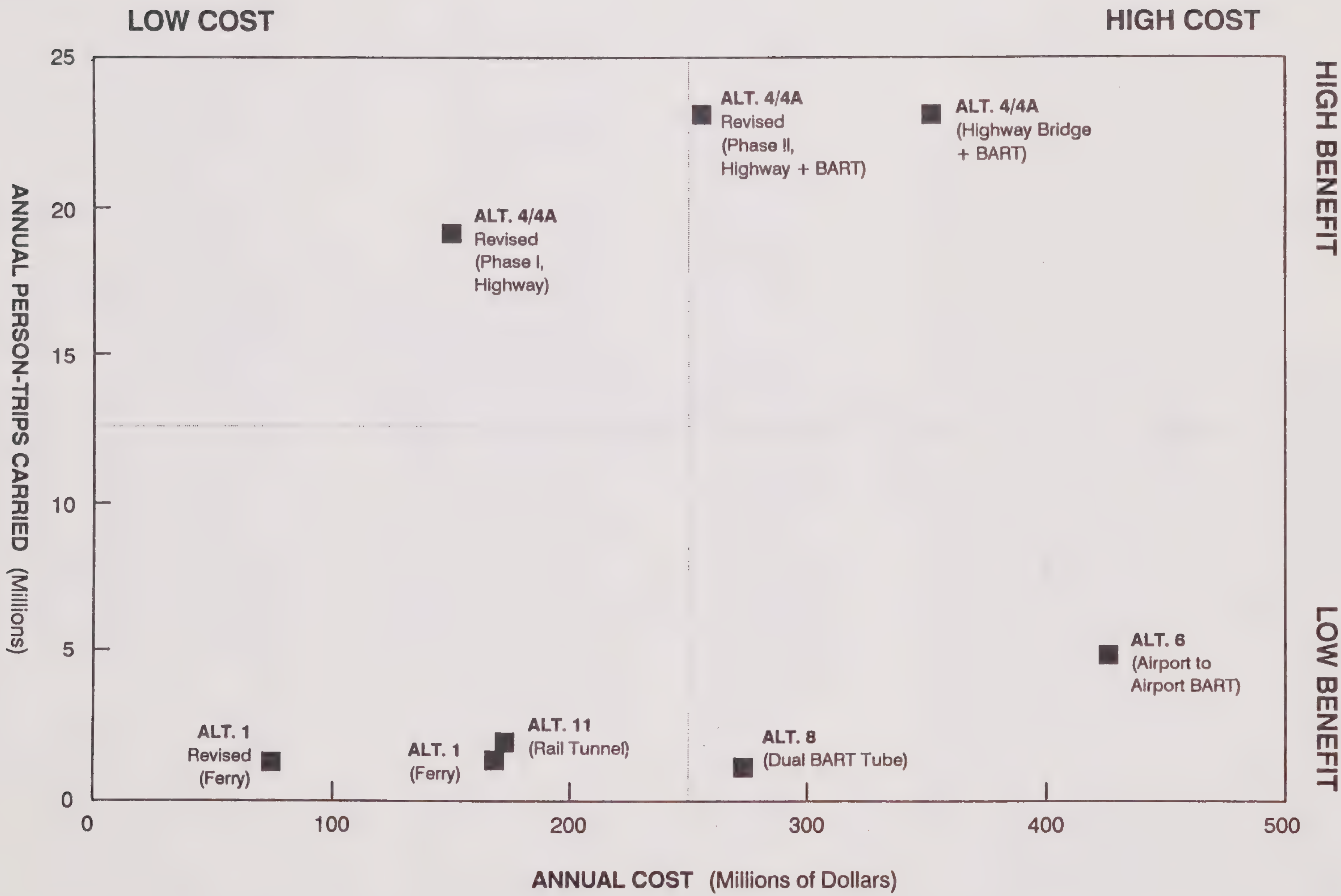


Figure 8-5
BENEFIT TO COST EVALUATION
Annual Person Trips to Annual Cost

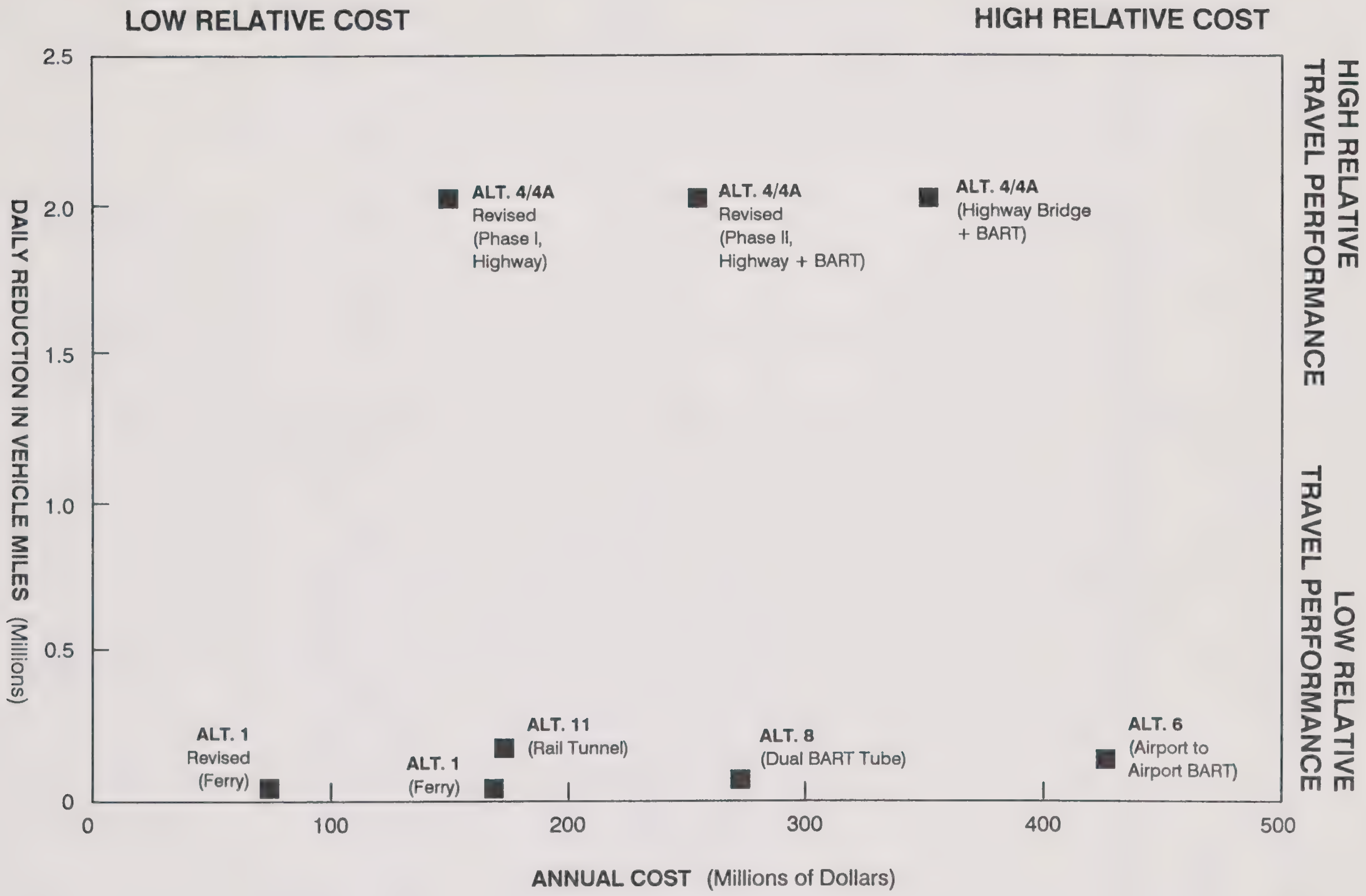


Figure 8-6
COST TO TRAVEL PERFORMANCE
Cost per Vehicle Mile Reduced

8.7 SUMMARY EVALUATION

Introduction

A summary evaluation table has been prepared which consolidates all of the "overall evaluation" ratings from each of the five subject areas of study:

- Travel System Performance
- Environmental and Socio/Economic Effects
- Cost Factors
- Financial Issues
- Cost to Travel Performance

No attempt has been made to put weights on various subject areas nor to compute an aggregate score for each alternative. Rather, the purpose is to summarize all of the separate evaluations which have been performed in a single table.

Evaluation Results

Figure 8-7 shows the summary evaluation results. Note that the shaded boxes indicate "high", "moderate", and "low" ratings for each respective evaluation criteria and that while "high" ratings are best for the travel performance, financial feasibility, and benefit to cost rows, "low" ratings are best for the impact and cost categories.

<table>
<tr><th>EVALUATION CRITERIA</th><th>ALT. 1 (Ferry)</th><th>ALT. 1 Revised (Ferry)</th><th>ALT. 4/4A (Bridge + BART)</th><th>ALT. 4/4A Revised (Phase I, Bridge)</th><th>ALT. 4/4A Revised (Phase II, Bridge + BART)</th><th>ALT. 6 (Airport BART Tube)</th><th>ALT. 8 (Dual BART Tube)</th><th>ALT. 11 (Rail Tunnel)</th></tr>
<tr><td>TRAVEL PERFORMANCE</td><td colspan="2">□</td><td colspan="3">■</td><td>⬓</td><td>□</td><td>⬓</td></tr>
<tr><td>ENVIRONMENTAL/ SOCIO-ECONOMIC IMPACT</td><td colspan="2">□</td><td colspan="3">■</td><td>■</td><td>⬓</td><td>⬓</td></tr>
<tr><td>COST</td><td>⬓</td><td>□</td><td>■</td><td>□</td><td>⬓</td><td>■</td><td>■</td><td>⬓</td></tr>
<tr><td>FINANCIAL FEASIBILITY</td><td>■</td><td>■</td><td>□</td><td>■</td><td>⬓</td><td>□</td><td>⬓</td><td>■</td></tr>
<tr><td>COST TO TRAVEL PERFORMANCE</td><td>⬓</td><td>⬓</td><td>⬓</td><td>■</td><td>■</td><td>□</td><td>□</td><td>⬓</td></tr>
</table>

LEGEND

□ Relatively Low

⬓ Relatively Moderate

■ Relatively High

Figure 8-7

SUMMARY EVALUATION

APPENDICES

APPENDIX A

APPENDIX A

List of Contacts and Reference Bibliography
for
Environmental Screening Report

1. Persons and Organizations Consulted

City of Benicia -- John Bunch, John Everts, Cecilia Nicholson
City of Alameda -- Jeff Boers
City of San Leandro -- Martin Vitz, Robert Taylor
City of Martinez -- Richard Cullen
City of San Francisco Planning Department
Alameda County Planning Department Staff
Contra Costa County Planning Staff
East Bay Dischargers Authority -- Ron Weiser
BCDC -- William Travis, Jeff Blanchfield, Steve McAdam
US Fish & Wildlife Service -- Monty Knudson
Port of Richmond -- William Powers
Port of Oakland -- Loretta Meyer
San Francisco Airport -- John Costas
San Francisco Bay Estuary Project -- Sam Zigler
San Francisco Bay National Wildlife Refuge -- Doug Poster
Save the Bay -- Marc Holmes
Audubon Society -- Arthur Feinstein
Sierra Club -- Totten Hefflefinger
Phillip Williams Associates -- Jeff Haltiner

2. Documents

BCDC -- *San Francisco Bay Plan*, January 1969, as amended July 1988
BCDC/MTC -- *San Francisco Bay Area Seaport Plan*, 1982, Revised 1988
ABAG -- *Regional Plan 1980, San Francisco Bay Area*
ABAG -- *Projections 90*, December 1989
ABAG -- *On Shakey Ground*, Seismic Risk Maps, 1987
MTC -- *Regional Transportation Plan*, Adopted October 1988
MTC -- *Resolution 2107*, Revised, 12/20/90
California Administrative Code, Section 15126
CALTRANS, *Local Programs Manual*, Chapter 1, 1981
CALTRANS, *Environmental Handbook*, Growth Inducing Impacts, March 1985
U.S. Fish and Wildlife Service, *Environmental Assessment on Additions to National Wildlife Refuge*, March 5, 1990
U.S. Fish and Wildlife Service, *National Wetland Inventory Maps*, Sheets for the Central Bay Area
U.S. Fish and Wildlife Service, *Concept Plan for Waterfowl Habitat Protection, San Francisco Bay*, November 1989
Division of Mines and Geology, Special Publication 78, *Earthquake Planning Scenario for a 7.5 Magnitude Earthquake on the Hayward Fault*, 1987
Governor's Board of Inquiry on the Loma Prieta Earthquake, *Competing Against Time*, May 1990
USGS and CDMG, Geologic Maps of the Bay Area

Alameda County General Plan: Eden Plan

Contra Costa County, *Rodeo Specific Plan*

Oakland Comprehensive Plan, Land Use Element, 1980

San Leandro General Plan, 1989

San Francisco Downtown Plan, 1986

Mission Bay Plan, September 1990

South San Francisco General Plan, 1986

Alameda Planning Department, *Harbor Bay Ferry Terminal Initial Study* and related documents, 1990

Metropolitan Oakland International Airport Master Plan Update, Chapter 7: Alternative Evaluation, July 1990

San Francisco Airport Final Draft Master Plan

San Francisco Bay Estuary Project, *Draft Status & Trends Reports on Wetlands and Land Use*, (Unpublished)

San Francisco Bay Estuary Project, *Status & Trends Report on Dredging*, 1990

Urban Land Institute, *Myths and Facts About Transportation and Growth*, 1989

Council on Environmental Quality, *The Growth Shapers*, May 1976

National Wetland Symposium Proceedings, *Urban Wetlands*, 1988

Bay Institute, *Citizens Report on Diked Historic Wetlands*, 1987

People for Open Space, *The Bay Area at a Crossroads*, July 1987

American Association for the Advancement of Science, *San Francisco Bay - Use and Protection*, Kockelman, Conomos & Leviton, eds. 1982

Norris & Webb, *Geology of California*, Wiley and Sons, 1976

Garrison, Urban Transportation and Land Use; Knight and Appelyard, Environmental Impacts of Transit Systems, in Grey, Hoel, eds. *Public Transportation*, Prentice Hall, 1979

William Green, CALTRANS, *Developing Methodology for Determining Growth Inducement Impacts from Transportation Facilities*, July 1979

Melvin Webber, *The BART Experience - What Have We Learned?* in The Public Interest, Fall 1976

Granholm, *Endangered Habitat, Report on the Status of Seasonal Wetlands*, National Audabon Society, 1989

LSA, *Biological Reports on the Harbor Bay Ferry Terminal*, January 1990

APPENDIX B

National Wetlands Inventory Maps

Classification System

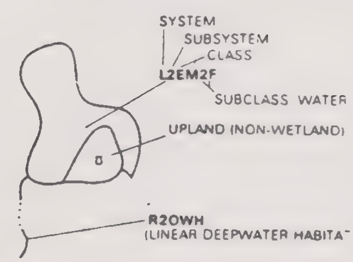
SYSTEM: M — MARINE

SUBSYSTEM: 1 — SUBTIDAL

- CLASS: RB — ROCK BOTTOM — Subclass: 1 Bedrock; 2 Rubble
- CLASS: UB — UNCONSOLIDATED BOTTOM — Subclass: 1 Cobble-Gravel; 2 Sand; 3 Mud; 4 Organic
- CLASS: AB — AQUATIC BED — Subclass: 1 Algal; 3 Rooted Vascular; 5 *Unknown Submergent*
- CLASS: RF — REEF — Subclass: 1 Coral; 3 Worm
- CLASS: OW — *OPEN WATER/Unknown Bottom*

SUBSYSTEM: 2 — INTERTIDAL

- CLASS: AB — AQUATIC BED — Subclass: 1 Algal; 3 Rooted Vascular; 5 *Unknown Submergent*
- CLASS: RF — REEF — Subclass: 1 Coral; 3 Worm
- CLASS: RS — ROCKY SHORE — Subclass: 1 Bedrock; 2 Rubble
- CLASS: US — UNCONSOLIDATED SHORE — Subclass: 1 Cobble-Gravel; 2 Sand; 3 Mud; 4 Organic



U — Primarily represents upland areas, but m unclassified wetlands such as man-modified photo-identifiable areas and/or unintentional

SYSTEM: R — RIVERINE

SUBSYSTEM: 1 — TIDAL; 2 — LOWER PERENNIAL; 3 — UPPER PERENNIAL; 4 — INTERMITTENT; 5 — UNKNOWN PERENNIAL

- CLASS: RB — ROCK — Subclass: 1 Bedrock; 2 Rubble
- CLASS: UB — UNCONSOLIDATED BOTTOM — Subclass: 1 Cobble-Gravel; 2 Sand; 3 Mud; 4 Organic
- CLASS: *SB — STREAMBED — Subclass: 1 Bedrock; 2 Rubble; 3 Cobble-Gravel; 4 Sand; 5 Mud; 6 Organic; 7 Vegetated
- CLASS: AB — AQUATIC BED — Subclass: 1 Algal; 2 Aquatic Moss; 3 Rooted Vascular; 4 Floating Vascular; 5 *Unknown Submergent*; 6 *Unknown Surface*
- CLASS: RS — ROCKY SHORE — Subclass: 1 Bedrock; 2 Rubble
- CLASS: US — UNCONSOLIDATED SHORE — Subclass: 1 Cobble-Gravel; 2 Sand; 3 Mud; 4 Organic; 5 Vegetated
- CLASS: **EM — EMERGENT — Subclass: 2 Nonpersistent
- CLASS: OW — *OPEN WATER/Unknown Bottom*

*STREAMBED is limited to TIDAL and INTERMITTENT SUBSYSTEMS, and comprises the only CLASS in the INTERMITTENT SUBSYSTEM

**EMERGENT is limited to TIDAL and LOWER PERENNIAL SUBSYSTEMS. The remaining CLASSES are found in all SUBSYSTEMS

SYSTEM: P — PALUSTRINE

- CLASS: RB — ROCK BOTTOM — Subclass: 1 Bedrock; 2 Rubble
- CLASS: UB — UNCONSOLIDATED BOTTOM — Subclass: 1 Cobble-Gravel; 2 Sand; 3 Mud; 4 Organic
- CLASS: AB — AQUATIC BED — Subclass: 1 Algal; 2 Aquatic Moss; 3 Rooted Vascular; 4 Floating Vascular; 5 *Unknown Submergent*; 6 *Unknown Surface*
- CLASS: US — UNCONSOLIDATED SHORE — Subclass: 1 Cobble-Gravel; 2 Sand; 3 Mud; 4 Organic; 5 Vegetated
- CLASS: ML — MOSS-LICHEN — Subclass: 1 Moss; 2 Lichen
- CLASS: EM — EMERGENT — Subclass: 1 Persistent; 2 Nonpersistent
- CLASS: SS — SCRUB-SHRUB — Subclass: 1 Broad-Leaved Deciduous; 2 Needle-Leaved Deciduous; 3 Broad-Leaved Evergreen; 4 Needle-Leaved Evergreen; 5 Dead; 6 *Deciduous*; 7 *Evergreen*
- CLASS: FO — FORESTED — Subclass: 1 Broad-Leaved Deciduous; 2 Needle-Leaved Deciduous; 3 Broad-Leaved Evergreen; 4 Needle-Leaved Evergreen; 5 Dead; 6 *Deciduous*; 7 *Evergreen*
- CLASS: OW — *OPEN WATER/Unknown Bottom*

SYSTEM: E — ESTUARINE

SUBSYSTEM: 1 — SUBTIDAL

- CLASS: RB — ROCK BOTTOM — Subclass: 1 Bedrock; 2 Rubble
- CLASS: UB — UNCONSOLIDATED BOTTOM — Subclass: 1 Cobble-Gravel; 2 Sand; 3 Mud; 4 Organic
- CLASS: AB — AQUATIC BED — Subclass: 1 Algal; 3 Rooted Vascular; 4 Floating Vascular; 5 *Unknown Submergent*; 6 *Unknown Surface*
- CLASS: RF — REEF — Subclass: 2 Mollusk; 3 Worm
- CLASS: OW — *OPEN WATER/Unknown Bottom*

SUBSYSTEM: 2 — INTERTIDAL

- CLASS: AB — AQUATIC BED — Subclass: 1 Algal; 3 Rooted Vascular; 4 Floating Vascular; 5 *Unknown Submergent*; 6 *Unknown Surface*
- CLASS: RF — REEF — Subclass: 2 Mollusk; 3 Worm
- CLASS: SB — STREAMBED — Subclass: 1 Cobble-Gravel; 2 Sand; 3 Mud; 4 Organic
- CLASS: RS — ROCKY SHORE — Subclass: 1 Bedrock; 2 Rubble
- CLASS: US — UNCONSOLIDATED SHORE — Subclass: 1 Cobble-Gravel; 2 Sand; 3 Mud; 4 Organic
- CLASS: EM — EMERGENT — Subclass: 1 Persistent; 2 Nonpersistent
- CLASS: SS — SCRUB-SHRUB — Subclass: 1 Broad-Leaved Deciduous; 2 Needle-Leaved Deciduous; 3 Broad-Leaved Evergreen; 4 Needle-Leaved Evergreen; 5 Dead; 6 *Deciduous*; 7 *Evergreen*
- CLASS: FO — FORESTED — Subclass: 1 Broad-Leaved Deciduous; 2 Needle-Leaved Deciduous; 3 Broad-Leaved Evergreen; 4 Needle-Leaved Evergreen; 5 Dead; 6 *Deciduous*; 7 *Evergreen*

SYSTEM: L — LACUSTRINE

SUBSYSTEM: 1 — LIMNETIC

- CLASS: RB — ROCK BOTTOM — Subclass: 1 Bedrock; 2 Rubble
- CLASS: UB — UNCONSOLIDATED BOTTOM — Subclass: 1 Cobble-Gravel; 2 Sand; 3 Mud; 4 Organic
- CLASS: AB — AQUATIC BED — Subclass: 1 Algal; 2 Aquatic Moss; 3 Rooted Vascular; 4 Floating Vascular; 5 *Unknown Submergent*; 6 *Unknown Surface*
- CLASS: OW — *OPEN WATER/Unknown Bottom*

SUBSYSTEM: 2 — LITTORAL

- CLASS: RB — ROCK BOTTOM — Subclass: 1 Bedrock; 2 Rubble
- CLASS: UB — UNCONSOLIDATED BOTTOM — Subclass: 1 Cobble-Gravel; 2 Sand; 3 Mud; 4 Organic
- CLASS: AB — AQUATIC BED — Subclass: 1 Algal; 2 Aquatic Moss; 3 Rooted Vascular; 4 Floating Vascular; 5 *Unknown Submergent*; 6 *Unknown Surface*
- CLASS: RS — ROCKY SHORE — Subclass: 1 Bedrock; 2 Rubble
- CLASS: US — UNCONSOLIDATED SHORE — Subclass: 1 Cobble-Gravel; 2 Sand; 3 Mud; 4 Organic; 5 Vegetated
- CLASS: EM — EMERGENT — Subclass: 2 Nonpersistent
- CLASS: OW — *OPEN WATER/Unknown Bottom*

MODIFIERS

In order to more adequately describe wetland and deepwater habitats one or more of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy. The farmed modifier may also be applied to the ecological system.

WATER REGIME

Non-Tidal

- A Temporarily Flooded
- B Saturated
- C Seasonally Flooded
- D Seasonally Flooded/Well Drained
- E Seasonally Flooded/Saturated
- F Semipermanently Flooded
- G Intermittently Exposed
- H Permanently Flooded
- J Intermittently Flooded
- K Artificially Flooded
- W Intermittently Flooded/Temporary
- Y Saturated/Semipermanent/Seasonal
- Z Intermittently Exposed/Permanent
- U Unknown

Tidal

- K *Artificially Flooded*
- L Subtidal
- M Irregularly Exposed
- N Regularly Flooded
- P Irregularly Flooded
- *S Temporary Tidal
- *R Seasonal Tidal
- *T Semipermanent Tidal
- *V Permanent Tidal
- U Unknown

*These water regimes are only used in tidally influenced freshwater systems

WATER CHEMISTRY

Coastal Halinity

- 1 Hyperhaline
- 2 Euhaline
- 3 Mixohaline (Brackish)
- 4 Polyhaline
- 5 Mesohaline
- 6 Oligohaline
- 0 Fresh

Inland Salinity

- 7 Hypersaline
- 8 Eusaline
- 9 Mixosaline
- 0 Fresh

pH Modifiers for all Fresh Water

- a Acid
- t Circumneutral
- i Alkaline

SOIL

- g Organic
- n Mineral

SPECIAL MODIFIERS

- b *Beaver*
- d *Partially Drained/Ditched*
- f *Farmed*
- h *Diked/Impounded*
- r Artificial Substrate
- s *Spoil*
- x Excavated

APPENDIX C

Table C-1
CAPITAL COST DETAIL
Alternative 1

Item	Number	Unit Cost	Total Cost
Ferry Boats	80-100	$ 2 - 3 million/boat	$ 160 - 300 million
Ferry Terminals			
o New Terminals	9	$ 20 - 25 million/location	$ 180 - 225 million
o Existing Terminals	8	$ 10 - 20 million/location	80 - 160 million
	SUBTOTAL		$ 260 - 385 million
	WITH 30% CONTINGENCY		$ 546 - 891 million
	RIGHT-OF-WAY COSTS		$ 24 million
	TOTAL COST		**$ 570 - 915 million**

Table C-2
CAPITAL COST DETAIL
Alternative 1, Revised

Item	Number	Unit	Total Cost
Ferry Boats	32-38	$ 2 - 3 million/boat	$ 64 - 114 million
Ferry Terminals			
o New Terminals	1	$ 20 - 25 million/location	$ 20 - 25 million
o Existing Terminals	5	$ 10 - 20 million/location	$ 50 - 100 million
SUBTOTAL			$134 - 239 million
WITH 30% CONTINGENCY			$ 174 - 311 million
RIGHT-OF-WAY COSTS			$ 3 million
TOTAL COST			**$177 - 314 million**

Services: Vallejo-SF, Rodeo-SF, Richmond-SF, Alameda-SF, Bay Farm-SF

Table C-3
CAPITAL COST DETAIL
Alternative 4

Segment/Type	Description	Length	Unit Cost	Total Cost
1. WEST BAY (0+00 to 15+00)				
Freeway (at grade)	8 lanes	0.5 miles	$ 2.4-4.0 million/mile	$ 1.2-2.0 million
BART (aerial)	double track	0.6 miles	$ 40-60 million/mile	24-36 million
Trestle Bridge				
o Vehicle	8 lanes	2.3 miles	$ 54-68 million/mile	124-156 million
o BART	double track	2.3 miles	$ 20-32 million/mile	46-74 million
BART (aerial station)	North Airport	n/a	$ 5-7 million/station	5-7 million
Park-Ride Facility	500 spaces	n/a	$ 10,000 per stall	5 million
		SUBTOTAL BART	$ 75 - 117 million	
		HIGHWAY BRIDGE COSTS	$ 130 - 163 million	
		SUBTOTAL HIGHWAY WITH 20% DESIGN	$ 156 - 196 million	
		TOTAL WEST BAY SEGMENT COSTS		$ 231 - 313 million
2. TRANSBAY (15+00 to 42+00)				
Main Bridge Span				
o Vehicle	8 lanes	2.3 miles	$ 117-135 million/mile	269-311 million
o BART	double track	2.3 miles	$ 35-40 million/mile	81-92 million
Trestle Bridge				
o Vehicle	8 lanes	2.8 miles	$ 54-68 million/mile	151-190 million
o BART	double track	2.8 miles	$ 20-32 million/mile	56-90 million
		SUBTOTAL BART	$ 137 - 182 million	
		HIGHWAY BRIDGE COSTS	$ 420 - 501 million	
		SUBTOTAL HIGHWAY WITH 20% DESIGN	$ 504 - 601 million	
		TOTAL TRANSBAY SEGMENT COSTS		$ 641 - 783 million

Table C-3 (continued)
CAPITAL COST DETAIL
Alternative 4

Segment/Type	Description	Length	Unit Cost	Total Cost
3. EAST BAY (42+00 to 88+00)				
Trestle Bridge				
o Vehicle	8 lanes	4.7 miles	$ 54-68 million/mile	$ 254-320 million
o BART	double track	4.7 miles	$ 20-32 million/mile	94-150 million
Freeway (at grade)	8 lanes	0.8 miles	$ 2.4-4.0 million/mile	1.9-3.2 million
Freeway (aerial)	8 lanes	2.1 miles	$ 32 - 48 million/mile	67-101 million
Freeway Interchange		n/a	$ 100 million/location	100 million
BART (aerial)	double track	3.2 miles	$ 40-60 million/mile	128-192 million
BART (at-grade)	double track	0.8 miles	$ 30 - 40 million/mile	24-32 million
BART (aerial station)	2 stations	n/a	$ 5-7 million/station	10-14 million
Park-Ride Facility	1,000 stalls	n/a	$ 2,500 per stall	2.5 million
SUBTOTAL BART			$ 256 - 388 million	
HIGHWAY COSTS			$ 425 - 527 million	
SUBTOTAL HIGHWAY WITH 20% DESIGN			$ 510 - 632 million	
TOTAL WEST BAY SEGMENT COSTS				$ 766 - 1,020 million
4. TOTAL OF WEST BAY, TRANSBAY, and EAST BAY SEGMENTS				
SUBTOTAL BART CONSTRUCTION COSTS				$ 468 - 687 million
SUBTOTAL BART VEHICLE COSTS				$ 164 million
SUBTOTAL HIGHWAY AND BRIDGE COSTS				$ 1170 - 1429 million
SUBTOTAL COSTS				$ 1,802 - 2,280 million
SUB-TOTAL COSTS WITH 30% CONTINGENCY				**$ 2,343 - 2,964 million**
RIGHT-OF-WAY COSTS				$ 427 million
TOTAL COST				**$ 2,770 - 3,391 million**
Bicycle/Pedestrian Facility				$130 - 160 million

Table C-4
CAPITAL COST DETAIL
Alternative 4, Revised

Segment/Type	Description	Length	Unit Cost	Total Cost
1. WEST BAY (0+00 to 15+00)				
Freeway (at grade)	4 lanes	0.5 miles	$ 1.2-2.0 million/mile	$ 0.6-1.0 million
Trestle Bridge				
o Vehicle	4 lanes	2.3 miles	$ 27-34 million/mile	62-78 million
Park-Ride Facility	500 spaces	n/a	$ 10,000 per stall	5 million
HIGHWAY BRIDGE COSTS				$ 68 - 84 million
SUBTOTAL HIGHWAY WITH 20% DESIGN				$ 82 - 101 million
2. TRANSBAY (15+00 to 42+00)				
Main Bridge Span				
o Vehicle	4 lanes[1]	2.3 miles	$ 60-80 million/mile	138-184 million
Trestle Bridge				
o Vehicle	4 lanes[1]	2.8 miles	$ 27-34 million/mile	76-95 million
HIGHWAY BRIDGE COSTS				$ 214 - 279 million
SUBTOTAL HIGHWAY WITH 20% DESIGN				$ 257 - 335 million

[1] Includes shoulder; does not include bike lanes.

Table C-4 (continued)
CAPITAL COST DETAIL
Alternative 4, Revised

Segment/Type	Description	Length	Unit Cost	Total Cost
3. EAST BAY (42+00 to 88+00)				
Trestle Bridge				
o Vehicle	4 lanes	4.7 miles	$ 27-34 million/mile	$ 127-160 million
Freeway (at grade)	4 lanes	0.8 miles	$ 1.2-2.0 million/mile	1-2 million
Freeway (aerial)	4 lanes	2.1 miles	$ 16 - 24 million/mile	34-50 million
Freeway Interchange		n/a	$ 100 million/location	100 million
Park-Ride Facility	1,000 stalls	n/a	$ 2,500 per stall	2.5 million
	HIGHWAY COSTS			$ 265 - 315 million
SUBTOTAL HIGHWAY WITH 20% DESIGN				$ 318 - 378 million
4. TOTAL OF WEST BAY, TRANSBAY, and EAST BAY SEGMENTS				
SUBTOTAL HIGHWAY & BRIDGE COSTS (W/DESIGN)				$ 657 - 814 million
			30% CONTINGENCY	$ 197 - 244 million
			RIGHT-OF-WAY COSTS	$ 427 million
			TOTAL PHASE I COST	**$ 1,281 - 1,485 million**
			Bicycle/Pedestrian Facility	$130 - 160 million

Table C-4 (continued)
CAPITAL COST DETAIL
Alternative 4, Revised

Segment/Type	Description	Length	Unit Cost	Total Cost
1. WEST BAY (0+00 to 15+00)				
BART (aerial)	double track	0.6 miles	$ 40-60 million/mile	24-36 million
Trestle Bridge				
o BART	double track	2.3 miles	$ 20-32 million/mile	46-74 million
BART (aerial station)	North Airport	n/a	$ 5-7 million/station	5-7 million
	SUBTOTAL BART			$ 75 - 117 million
2. TRANSBAY (15+00 to 42+00)				
Main Bridge Span				
o BART	double track	2.3 miles	$ 20-26 million/mile	46-60 million
Trestle Bridge				
o BART	double track	2.8 miles	$ 20-32 million/mile	56-90 million
	SUBTOTAL BART			$ 102 - 150 million

Table C-4 (continued)
CAPITAL COST DETAIL
Alternative 4, Revised

Segment/Type	Description	Length	Unit Cost	Total Cost
3. EAST BAY (42+00 to 88+00)				
Trestle Bridge				
o BART	double track	4.7 miles	$ 20-32 million/mile	94-150 million
BART (aerial)	double track	3.2 miles	$ 40-60 million/mile	128-192 million
BART (at-grade)	double track	0.8 miles	$ 30 - 40 million/mile	24-32 million
BART (aerial station)	2 stations	n/a	$ 5-7 million/station	10-14 million
	SUBTOTAL BART			$ 256 - 388 million
4. TOTAL OF WEST BAY, TRANSBAY, and EAST BAY SEGMENTS				
	SUBTOTAL BART CONSTRUCTION COSTS			$ 433 - 655 million
	BART VEHICLE COSTS			$ 164 million
	TOTAL PHASE II COST			**$ 597 - 819 million**

Table C-5
CAPITAL COST DETAIL
Alternative 6

Segment/Type	Description	Length	Unit Cost	Total Cost
1. WEST BAY (0+00 to 25+00)				
BART				
o at-grade	double track	1.0 miles	\$ 30-40 million/mile	\$ 30-40 million
o suburban subway		2.5 miles	\$ 70-100 million/mile	175-250 million
o transbay tube		2.3 miles	\$ 160-170 million/mile	368-391 million
	SUBTOTAL SEGMENT COST			\$ 573 - 681 million
2. TRANSBAY (25+00 to 55+00)				
BART				
o transbay tube	double track	5.7 miles	\$ 160-170 million/mile	\$ 912 - 969 million
	SUBTOTAL SEGMENT COST			\$ 912 - 969 million
3. EAST BAY - SEGMENT A (55+00 to 80+00)				
BART				
o at-grade	double track	0.2 miles	\$ 30-40 million/mile	\$ 6-8 million
o suburban subway		1.5 miles	\$ 70-100 million/mile	105-150 million
o transbay tube		3.0 miles	\$ 160-170 million/mile	480-510 million
Subway Stations			\$ 25-45 million/station	25-45 million
Parking	1000 spaces		\$ 10,000/stall	10 million
	SUBTOTAL SEGMENT COST			\$ 626 - 723 million
4. EAST BAY - SEGMENT B (80+00 to 106+00)				
BART				
o at-grade	double track	0.8 miles	\$ 30-40 million/mile	\$ 24-32 million
o flyover		1.2 miles	\$ 40-60 million/mile	48-72 million
o aerial		2.8 miles	\$ 40-60 million/mile	112-168 million
Aerial Station			\$ 5-7 million/station	5-7 million
Parking	500 stalls		\$ 2,500 per stall	12.5 million
	SUBTOTAL SEGMENT COST			\$ 202 - 292 million

Table C-5 (continued)
CAPITAL COST DETAIL
Alternative 6

Segment/Type	Description	Length	Unit Cost	Total Cost
5. EAST BAY - SEGMENT C (106+00 to 114+00)				
BART				
o flyover		0.2 miles	$ 40-60 million/mile	8-12 million
o aerial		1.3 miles	$ 40-60 million/mile	52-78 million
Aerial Station			$ 5-7 million/station	5-7 million
	SUBTOTAL SEGMENT COST			$ 65 - 97 million
6. TOTAL OF WEST BAY, TRANSBAY, and EAST BAY SEGMENTS				
	SUBTOTAL SEGMENT COSTS			$ 2,363 - 2,756 million
	SUBTOTAL BART VEHICLE COSTS			164 million
	SUBTOTAL COSTS			$ 2,527 - 2,920 million
SUB-TOTAL COSTS WITH 30% CONTINGENCY				**$ 3,285 - 3,796 million**
	RIGHT-OF-WAY COSTS			$ 147 million
	TOTAL COST			**$ 3,432 - 3,943 million**

Table C-6
CAPITAL COST DETAIL
Alternative 8

Segment/Type	Description	Length	Unit Cost	Total Cost
1. WEST BAY/TRANSBAY (0+00 to 29+00)				
BART				
o Urban subway	double track	1.5 miles	$ 170-210 million/mile	$ 255-315 million
o Transbay tube		3.5 miles	$ 160-170 million/mile	560-595 million
o Suburban subway		0.5 miles	$ 70-100 million/mile	35-50 million
Subway Stations	three		$ 25-45 million/station	75-135 million
	SUBTOTAL SEGMENT COST			$ 925 - 1,095 million
2. EAST BAY (29+00 to 58+00)				
BART				
o Suburban subway		0.6 miles	$ 70-100 million/mile	$ 42-60 million
o Aerial		3.3 miles	$ 40-60 million/mile	132-198 million
o Urban subway		1.7 miles	$ 170-210 million/mile	289-357 million
Station Modification	12th/19th Street			10-15 million
	SUBTOTAL SEGMENT COST			$ 473 - 630 million
3. TOTAL OF WEST BAY, TRANSBAY, and EAST BAY SEGMENTS				
	SUBTOTAL SEGMENT COSTS			$ 1,398 - 1,725 million
	SUBTOTAL BART VEHICLE COSTS			164 million
	SUBTOTAL COSTS			$ 1,562 - 1,889 million
SUB-TOTAL COSTS WITH 30% CONTINGENCY				**$ 2,031 - 2,456 million**
	RIGHT-OF-WAY COSTS			$ 138 million
	TOTAL COST			**$ 2,169 - 2,594 million**

Table C-7
CAPITAL COST DETAIL
Alternative 11

Segment/Type	Description	Length	Unit Cost	Total Cost
1. WEST BAY/TRANSBAY (0+00 to 28+00)				
Railroad				
o Tunnel		5.4 miles	$ 190-200 million/mile	$ 1,026-1,080 million
Subway station	one		$ 25-30 million/station	25-30 million
	SUBTOTAL SEGMENT COST			$ 1,051 - 1,110 million
2. EAST BAY (28+00 to 40+00)				
Railroad				
o At-grade	double track	2.3 miles	$ 4-6 million/mile	$ 9-14 million
	SUBTOTAL SEGMENT COST			$ 9 - 14 million
3. TOTAL OF WEST BAY, TRANSBAY, and EAST BAY SEGMENTS				
	SUBTOTAL SEGMENT COSTS			$ 1,060 - 1,124 million
	SUBTOTAL RAILROAD VEHICLE COSTS			64 million
	SUBTOTAL COSTS			$ 1,124 - 1,188 million
TOTAL COSTS WITH 30% CONTINGENCY				**$ 1,461 - 1,544 million**
	RIGHT-OF-WAY COSTS			$ 57 million
	TOTAL COST			**$ 1,518 - 1,601 million**

Table C-8
OPERATING COST DETAIL
Annual Cost Summary by Alternative

Alternative	Number of Vehicles	Annual Revenue Hours	Operating Cost Per Revenue Hr.	Vehicle Operat. Costs	Station Operat. Costs	Total Operat. Costs
1	80	208,000	$ 400-550	$ 83-114 M	$ 4 M	$ 87-118 M
4	100	188,000	$ 145	$ 27 M	-	$ 30 M
			Bridge Operations/Maintenance:		$ 3 M	
6	100	188,000	$ 145	$ 27 M	-	$ 27 M
8	100	188,000	$ 145	$ 27 M	-	$ 27 M
11	8 trains	20,800	$ 950	$ 19.8 M	-	$ 20 M

Table C-9
PROJECTED IMPLEMENTATION SCHEDULE
Alternative Costs Apportioned by Year

Alternative	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Alternative 1:										
o Right-of-way	-	40%	60%							
o Vehicle Acq.	1%	9%	40%	50%						
o Construction	-	-	-	-	50%	40%				
-Process/Envir.	1%	1%								
-Design	-	1%	2%	4%						
Alternative 4:										
o Right-of-way	-	20%	20%	20%	20%	20%				
o Vehicle Acq.	-	-	-	-	-	-	10%	40%	40%	10%
o Construction	-	-	-	-	-	-	40%	20%	20%	10%
-Process/Envir.	1%	1%	1%							
-Design	-	1%	-	1%	3%	2%				
Alternative 6:										
o Right-of-way	-	25%	25%	25%	25%					
o Vehicle Acq.	-	-	-	-	-	20%	40%	40%		
o Construction	-	-	-	-	-	40%	30%	20%		
-Process/Envir.	1%	1%	1%							
-Design	-	1%	1%	3%	2%					
Alternative 8:										
o Right-of-way	-	-	-	40%	60%					
o Vehicle Acq.	-	-	-	-	-	20%	40%	40%		
o Construction	-	-	-	-	-	40%	30%	20%		
-Process/Envir.	1%	1%	1%							
-Design	-	1%	1%	3%	2%					
Alternative 11:										
o Right-of-way	-	-	-	40%	60%					
o Vehicle Acq.	-	-	-	-	10%	40%	40%	10%		
o Construction	-	-	-	-	-	40%	30%	20%		
-Process/Envir.	1%	1%	1%							
-Design	-	1%	1%	3%	2%					

APPENDIX D

Bonding Assumptions: Bonding capacity is estimated assuming a 30-year bond with a 7.5 percent interest rate. We assumed a 25 percent coverage ratio (ratio between net revenues and bond debt payments) and a 1 percent issuance cost.

Construction Schedules and Start of Operations: For all alternatives, assumed that projects would be in place starting in the Year 2010. For most alternatives, construction begins several years in advance. Construction schedules are specified in the Cost Report of this study.

Elasticity: Elasticity estimate of -4.25 percent based on sensitivity analysis conducted by MTC using travel forecast model. This estimate means that for every 100 percent increase in the toll rate, a 4.25 percent drop in toll paying traffic would follow. A 400 percent toll increase (as assumed for the $4 toll increase scenario) translates into a 17 percent drop in toll paying traffic.

Transit Operating Costs: Mass transit alternatives would all incur operating costs once they were constructed. The estimated cost of operations is discussed in the Cost Report. Except for Alternative 1 (Ferry Operations), operating costs represent only a fraction of the total cost to construct and operate the system; therefore, we are not including operating costs in the Financial Analysis. For Alternative 1, we do discuss the potential for using toll revenues for ferry operations. It is assumed that operations of the other mass transit alternatives would be subsumed as part of the system's overall operating budget.

Private Sector Opportunity Cost of Capital: For private sector investment analysis, we used 13 percent as the opportunity cost of capital. This figure is similar to that used by the State Public Utilities Commission in evaluating capital projects of PG&E, and is equal to PG&E's current Return on Owner's Equity.

Toll Structure: Toll increase assumptions are applied equally to commercial as well as commute traffic. All toll increases are assumed to occur in the Year 2000, except as noted in the breakeven analysis section.

Total Financial Capacity: Defined as the maximum bonding capacity plus any prior year balances available after funding of bridge operating costs, capital projects, existing bond payments, rehabilitation costs.

Travel Growth Rates on New Bridge: Assumed that travel would grow at 2.9 percent per year (similar to Dumbarton Bridge) once bridge is opened (see below).

Travel Growth Rates on Existing Bridges: MTC made a Year 2010 forecast for bridge usage. The Financial Analysis assumes an annual compound growth rate from 1989 actuals to MTC's Year 2010 forecast.

Traffic is assumed to grow until it reaches the maximum "practical" capacity defined as 56 percent of total absolute capacity. For comparison, the Bay Bridge is currently approximately 50 percent of absolute capacity.